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TYPHOID FEVER AT PHILADELPHIA AND PATERSON continues to cause great anxiety, and Newark is now having a large number of cases. The situation at Philadelphia is reviewed in our editorial columns. At Paterson, Dr. John L. Leal, Health Officer, made a report last week in which he attributed the recurrence of the disease at frequent intervals, of late, to a case on a small tributary of the Passaic, about 8,000 ft. above the water-works intake. The case occurred last August. From the fact that the outbreaks in Paterson since then have followed heavy rains, Dr. Leal concludes that the germs from this case lodged in marshy land during the dry weather and have been washed into the river by each heavy rain. At Newark, 196 cases were reported during the first three weeks in March, there being 34 new cases on Tuesday of this week. The cause is said to be the pumping of water from the Passaic River at Belleville during the cold spell in February. The city has been comparatively free from the disease since the introduction of the Pequannock supply in 1892, as we showed in our issue of Sept. 30, 1897.

THE WATER SUPPLY OF CHICAGO is said to be greatly improved by the partial diversion of sewage from the lake through one of the new intercepting sewers. The opinion is based on analyses of hundreds of samples made during the past few months, and has been made public by Mr. Arthur Reynolds, Health Commissioner of Chicago.

THE JERSEY CITY WATER CONTRACT has withstood one attack in the courts, but others are threatened. Two taxpayers' applications for a writ of certiorari were recently heard in the State Supreme Court. It was claimed that the contract, as executed, contained provisions not in the resolution calling for bids, to which the court replied that as the extra clauses are manifestly in favor of the city, and impose a burden on the contractor, the objection is invalid. Other reasons were that insufficient time was given contractors to prepare bids and that the guarantee check of $100,000 required of bidders was excessive. These objections the court also holds as insufficient, and dismisses the application. It is reported that further applications, with a host of new objections, will be submitted for a review of the award. In addition, the Passaic Valley Protective Association, whose aim is to prevent nuisances through pollution of the Passaic River and diminution of its flow, has notified the contractor that it will bring suit to protect the rights of riparian owners to an undiminished flow of the river, the contract calling for a possible ultimate daily supply of 70,000,000 gallons from the Rockaway River, a tributary of the Passaic.

ADDITIONAL SEWAGE FILTER BEDS FOR WESTborough, Mass., are declared necessary by the State Board of Health of Massachusetts, to avert a possible serious nuisance this summer. On complaint of the town of Northborough that unpurified sewage was being discharged into the Assabet River by Westborough the board has investigated and reported on the subject. It states that the town of Westborough has not provided a proper intermittent filtration area in accordance with the plans which it submitted to the board some years ago. That the beds in use, besides being improperly constructed, are inadequate in area, and that much crude and partially purified sewage is discharged into the river. Analyses of water above and below the outlets from the bed, made during 1898, confirm these statements.

THE ACTION OF CARBONIC ACID IN WATER ON iron pipes is shown in two cases in "Stahl und Eisen." The first case was in 1¼ miles of iron pipe laid near Beuthen, Silesia, connecting a pumping station and a reservoir. After two years' use the pipe began to leak; and it was found to be deeply pitted and punctured along the upper third of the pipe, the rest of the pipe being intact. The cast iron in the pipe was of average quality. The second case was at Johann-on-the-Saar, where the water, which is soft and very pure, came from the carboniferous deposits of the Saarbruck district. After some time the water passing through this pipe became a dirty brown and unfit for use, though the source remained unchanged. An examination showed that these waters were saturated with carbolic acid; or 126 cubic centimeters CO_2 per litre, either free or as bicarbonate. Attempts to remove it by aeration failed, and atomizers are now being tried.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Norfolk & Western Ry., at Ada, Va., as the result of a freight train breaking in two. Three east-bound freight trains were coming down the mountain, and for some reason the first train stopped. The second train broke in two and ran into the first, and in a few minutes the third train, which had not been flagged, ran into the wreck. Three men were killed and several others more or less seriously injured.

A SAW-MILL BOILER EXPLODED at Minnie Station, near Altoona, Pa., on March 17, killing three men and injuring six others.

THE EXPLOSION OF A WATER-TUBE BOILER on board the British first-class cruiser "Terrible" is reported to have occurred on March 12. It is further stated that one man was killed, one fatally injured and several others badly scalded. The "Terrible" is a steel sheathed vessel of 14,200 tons displacement, 500 ft. long, 71 ft. beam, with a draft of 27 ft. and 25,000 I. HP. She was built at Glasgow in 1895, at a cost of $3,407,095.

A DISASTROUS FIRE occurred at Omaha, Neb., on March 21, which resulted in the death of two women and the injury of about 15 others. Press reports state that a meeting of a women's lodge was being held in a room on the upper floor of the Patterson Block, when fire started in the hallway, cutting off escape. The women remained at the windows until the fire forced them to jump. Apparently, the fire department was unable to do anything to save them.

THE FLASH-POINT OF PETROLEUM was lately the subject of debate in the English Parliament. A motion to raise the flash-point from 73 to 100 was finally rejected by a vote of 244 to 159, after a lengthy discussion on American competition. One speaker said that the proposed action would rule out 78% of the oil now used in England; but an American offer was quoted for supplying oil at 100 flash-point for only ½-ct. above the present price per gallon.

MAGAZINES FOR NAVAL AMMUNITION, and factories for making high explosives, are to be built at various points in the United States, at a total estimated cost of over $1,000,000. One of the largest of these will probably be located on the Palisades, near Edgewater. At present the only naval magazine near New York is at Fort Lafayette; and this post, which belongs to the army, is too small and too much exposed. The new magazine would be at the foot of the cliffs and the river would be dredged so that the largest battleship could come alongside the dock to be built. It will include a complete plant for the manufacture of explosives, and assembling and charging shells. Another large plant will be erected at Indian Head, near Washington, which will be devoted mainly to the manufacture of smokeless powder.

A GUN-CAMERA, for the Smithsonian Institute, is said to be under construction in Chicago. It is to be used for scientific purposes and is to be capable of taking a clear negative with an exposure of 1-600, or even 1-1,000 of a second. It will be fitted with delicate apparatus for measuring the angle of the camera at the time of exposure. With such a camera a clear picture of a bird in full flight could be taken.

THE MANCHESTER SHIP CANAL, for the six months ending with December last, had sufficient revenue to pay the interest on the first and second debentures and leave a balance of $83,350. During this half-year 1,421,705 tons of paying freight passed through the canal, compared with 1,173,880 tons for the first half of the year, and 1,108,605 tons for the December half of 1897. The total tonnage in 1898 was 2,595,585 tons, compared with 925,659 tons in 1894, the opening year. The last half-year's gross revenue from the canal proper was $647,650; and the expenditures were $458,025, leaving a net balance of $189,575. The Bridgewater canal system added to this balance a net profit of $113,700. The interest on first and second mortgages amounted to $223,710, and the balance was paid over to the Corporation of Manchester, on account of interest on debentures held by it; there is still a balance of $4,137,400 due that corporation for interest. A special correspondent of the "New York Commercial," in sending in these items, says that there is no hope that the canal company will ever pay all its obligations.

PLANS FOR THE NEW YORK HARBOR IMPROVEments, by straightening and deepening the channel from the sea, have been approved, and the specifications have been prepared by Major Henry M. Adams, Corps of Engineers, U. S. A., under the direction of Gen. Wilson, Chief of Engineers. The work will be advertised for letting without delay. The plans call for the removal of 40,000,000 cu. yds. of material, which is to be dumped seven miles outside of Sandy Hook. Work must begin within twelve months; and during at least eight months of the second year material must be moved at the rate of 40,000 cu. yds. per month; and during the second and succeeding years this rate shall be increased to 1,200,000 cu. yds. per month.

THE COAST SURVEY STEAMER "PATHFINDER," built at the Crescent Shipyards, Elizabethport, N. J., made her trial trip on March 17. The contract called for a speed of 12 knots at 118 revolutions. In the trial, for 12 hours under natural draft, she made 12.65 knots at 116 revolutions. Under forced draft she made 13.35 knots, with an additional consumption of 1½ tons of coal per hour. The "Pathfinder" has a single screw, with triple-expansion engines and steam steering gear. She is 200 ft. long over all, 20 ft. beam and 14 ft. draft. It is expected that she will first be sent to the Philippines for survey work among the islands.

THE CASKS TO BE USED IN TESTING ARCTIC currents, on plans devised by Admiral George M. Melville, Chief of the Bureau of Steam Engineering, and now being carried out by the U. S. government and the Geographical Society of Philadelphia, are described as follows: Each cask is 36 ins. long and 12 ins. inside diameter with sides 1¼ ins. thick. They are made of shaped, heavy oak staves, and have conical points; they are bound with heavy iron hoops, designed to withstand corrosion for several years. An opening in the center is secured with a brass rod and is protected by rubber gaskets. Each cask will be numbered, and contain inside a glass bottle, hermetically sealed, which is to contain the record made by the vessel at the time of dropping the cask overboard; this record will include the date, place, exact longitude and latitude, name of vessel, home port, etc. A duplicate of this record is to be sent to the Hydrographic Office; and captains of vessels are instructed to look out for these casks; to open them, take a copy of the contents and return them to the sea, with the record of finding added. A money prize is awarded for this service.

ANTARCTIC EXPLORATION is again exciting interest. Lieut. Gerlache, of the Belgian Navy, assisted by the Belgian government, sailed from Antwerp, on the "Belgica," on Aug. 16, 1897. He was accompanied by a staff of scientists, including Dr. F. A. Cook, of Brooklyn, and was last heard from on Dec. 27, 1897, near Tierra del Fuego, bound for Graham's Land. He was due at Melbourne in April, 1898. Another expedition was organized at the cost of Sir George Newes, who sent out the "Southern Cross" from London on Aug. 22, 1898, under Capt. C. E. Borchgrevink. The steamer landed its captain, ten men, dogs and supplies at Cape Adare, the nearest point of Victoria Land, and has reached New Zealand on its return. Cape Adare is in 71° 23' south latitude, 169° 56' east longitude, and Capt. Borchgrevink proposed to winter there and then start towards the south pole in the spring. The Germans are now organizing a still larger expedition to be sent south under Dr. Erich von Drygalski, a distinguished Greenland explorer, at an estimated cost of $200,000. The British Royal Geographical Society has voted $25,000 to assist in this exploration. Sir John Ross discovered Victoria Land in 1841, and it has been visited but once since, in 1895, leaving out the above expeditions.

A TELEGRAPH LINE FROM SKAGUAY to Dawson City will be constructed by the Canadian government, and the construction party, under the charge of Mr. Frank Richardson, Assistant Electrician of the Canadian Pacific Ry., left Ottawa on March 4. The distance is 600 miles, and the estimated cost is $250 per mile, or a total cost of $150,000. It is expected that this line will be in operation by Nov. 15, 1899. Its completion will bring Dawson City within six days' communication with Ottawa. Later either a cable will be run between Vancouver and Skaguay or a land line will be run from Quesuelle. In the latter case the cost is estimated at $350,000.

THE MONTROSE IRRIGATION CANAL, COLORADO.

W. P. Hardesty, C. E.*

The Montrose canal is in Montrose Co., in western Colorado, and mostly near the narrow-gage line of the Denver & Rio Grande R. R. It is now owned by the Travelers' Insurance Co., of Hartford, Conn. This canal possesses much of interest on account of the comparatively early day at which it was constructed, some unusual features to contend with in maintaining it, and the thorough manner in which it is kept in operation without regard to the expense of the same.

The canal takes water from the Uncompahgre River and waters land in the valley of the same name. It leaves the river about eight miles south, or above the town of Montrose, and runs northwesterly for about 30 miles. By tapping the river above any of the other numerous ditches, it reaches parts of the table land of the valley far back of that watered by the others. The river and valley have an average fall of about 50 ft. to the mile in their northerly course.

The canal was first built in 1883-84. It was constructed by the Uncompahgre Canal Co., and was then called the Uncompahgre Canal. The promoter and manager was Mr. T. C. Henry, who financed and carried mostly through many similar undertakings in Colorado during the eighties, but whose methods brought him into great disrepute. This canal was taken by the Travelers' Insurance Co. for debt in 1886, and the management of the property is carried on in the name of the Montrose Canal Co.

The chief engineer of the canal was Mr. Walter H. Graves, now Superintendent of Irrigation for the Crow Indian Agency, Montana. He was assisted by Mr. E. H. Kellogg and Mr. J. C. Ulrich, both of Denver. As first built there were 18 flumes aggregating more than a mile in length, the longest one 512 ft. Nearly 850,000 ft. B. M. of lumber was used in their construction. The entire cost of the canal was $210,000. Many of the wooden structures have been altered, rebuilt or else dispensed with entirely during the 14 or 15 years since the canal was first put through. All the work done since the season of 1891 has been carried out by Mr. Ulrich as chief engineer. Mr. Ulrich resigned in 1897.

The head-gate is 30½ ft. long over all, consisting of 5 screw-stem gates, each 5¾ ft. wide by 10 ft. high. The gate has needed replacing for several years, and Mr. Ulrich got up plans for a new one, the most marked novelty of which, Fig. 1, was the use of ball-bearings for the wheel-nut that turns on the screw-stem and so operates the gate. Though never used for this gate, similar plans embodying the same features were used by Mr. Ulrich in building the new head-gates of the Monte Vista canal in the San Luis Valley in 1892, which is also owned by the Travelers' Insurance Co.

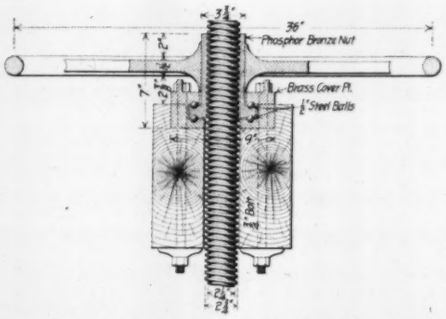

Fig. 1.—Wheel Nut with Ball Bearings for Screw Stem of Head Gate of the Monte Vista Irrigation Canal.

The Montrose canal has never carried over 4 ft. depth of water. Its bottom width at the head is 20 ft., and it runs from this to 26 ft. for the first 2¼ miles. The grade for the first ½-mile is 0.05, or 2.64 ft. per mile; for the next one mile (where the bottom is in a heavy gravel) it is 0.4 to 0.5, then 0.2 to 0.3 for 1½ miles to the end of the third mile. There is only one bank except where the line runs through a flat country. The side slopes of excavations are 1 to 1 in earth and ¼ to 1 in rock. The banks have slopes of 2½ to 1 on the inside and 1½ to 1 on the outside. The capacity of the canal is about 300 cu. ft. per sec.

The canal runs through a smooth country for the first 2½ miles. Then it begins to follow the slope leading up to the mesa land, which is 100 ft. to 200 ft. above the bottom land. The top is reached at 6¾ miles from the head.

At about 1½ miles the canal is flumed across Horse Fly Creek. Fig. 2 shows the type of all the new flumes used on the canal. This flume is 40½ ft. long, the length of the flumes given being always the length of the floors between the bulkheads of the aprons. At the lower end of this flume is a drop of 6 ft., the grade line adopted having carried the bottom of the canal too near the surface of the ground. At three miles Dolores Creek is crossed by a 114-ft. flume. At 5½ miles Happy Canyon is crossed by a flume nearly 300 ft. long. This flume is nearly 50 ft. above the creek below. It is 16 ft. wide, and provision was made for carrying the sides (now only 5 ft. high) up to 7 ft. It has a fall of 0.58 ft. per 100 ft. As first built this flume had 24-ft. spans between bents. The method of supporting this and all the other of the original flumes was quite peculiar. In this type, in place of stringers from bent to bent, what are practically arches are used, as is shown in the view, Fig. 3. Occupying the middle one-half of the 24-ft. span are 12-ft. stringers, or caps, each connected at each end with an inclined brace or batter post reaching down to a post of the bent. On the 12-ft. stringers three floor-beams are laid, and the planking is laid on this, making the 6-ft. span at each end to reach the bents without any supports between. The stringers and braces are 8 × 10 ins.; the bent posts 10 × 10.

Some of the flumes of this type are still in use after having served for 14 years, and they were all designed by Mr. Kellogg as engineer. About eight years ago this system of supports was taken out of the Happy Canyon flume and replaced by four 5 × 24 stringers for the full length of 24 ft. These stringers were tested very severely, as with 5 ft. depth of water the load for the 24-ft. span was 60 tons, so in the winter of 1896 intermediate bents were put in, reducing the span to 12 ft. At this time also the planks forming the bottom and sides were tarred. The old bents were founded on piles driven 6 or 7 ft. deep, but the new ones are set on short mud-sills at that depth. Two waste-gates are set in the lower side of the flume at the upper end, and discharge waste-water out onto the rock formation.

Along the hill-side section and four to five miles from the head there has been much trouble and expense from the banks of the canal and ground below them gradually sliding downward and outward, making great gaps in the canal. This began soon after the construction. Though the slope here is not over 20°, the ground is an adobe clay and shale which when wet develops a tendency to slide. In the worst places the ground for nearly ¼-mile below the canal has moved outward, reaching onto the bottom land. The worst of the slides occurred inside of about three years, and they have steadily lessened since then. The canal has been restored by cutting back into the upper side and using the earth to raise the bank as it settled. In this manner the center line has been thrown into the hill for as much as 18 ft. for a considerable distance, while the original bank can now be seen 50 to 100 ft. below the canal. These slides extend over about 1½ miles of line, though the worst cover only about ¾ of a mile. The management has never permitted the water to cease running during all the trouble with these slides, and has kept a force of men cutting back into the bluff, when needed, to get behind the fissure formed, and using the dirt to raise the bank. For a period of two or three weeks in one season the

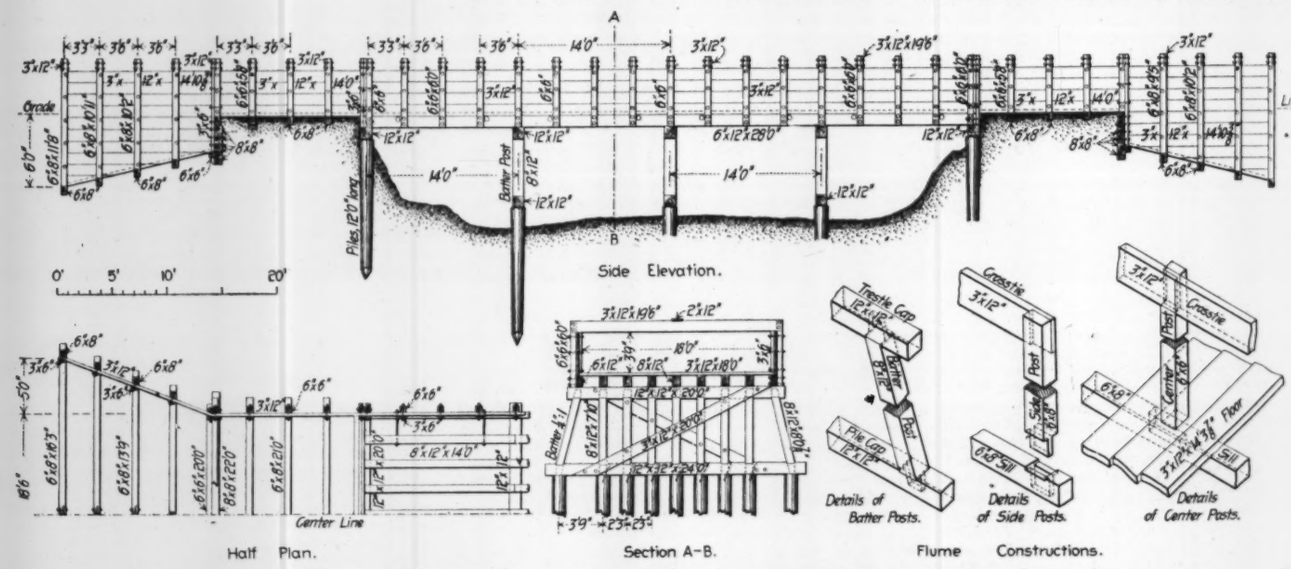

FIG. 2.—SPRING CREEK FLUME, MONTROSE IRRIGATION CANAL, COLORADO.

The diversion of the water into the head of the canal is done by means of a brush or willow mattress dam. Each bundle is bound in two places with heavy iron wire. The bundles are laid down in a row, two or three layers deep, and with butts upstream. Stakes about 8 ft. long are then driven through these and 6 or 7 ft. into the bed of the river, which pin all the bundles down. To keep logs away from the head-gate during floods, a board protection is provided with the boards not reaching below the low-water level.

*Progress Building, Salt Lake City, Utah.

bank would settle 2 or 3 ft. vertically and more horizontally every night after having been raised during the day, so a night force was kept at work adding to the bank. A force of 30 men besides teams was kept at work for nearly three months during that season.

Only one break ever occurred on this canal, and this was due to a cloud-burst which suddenly filled the canal with water and caused one end of an embankment at a gulch to give way. Some drainage gulches which are not large enough to justify flumes have stone culverts for passing water under the canal.

The canal reaches the top of Spring Creek Mesa (the first one to be irrigated) at 6¾ miles, and at 7 miles the No. 1 lateral is taken out through two gates 4½ ft. wide each.

At eight miles Spring Creek is crossed by a flume 84 ft. long, shown in Fig. 2, already mentioned. The flumes at Horse Fly, Dolores and Spring Creeks are all new, having replaced the old ones over 230 ft., and then is taken out through a headgate into a constructed ditch, as before. This headgate has three gates, each 5⅔ ft. wide by 4½ ft. deep. In the creek here are placed two wastegates to let the water run on if necessary, each 5½ ft. by 4 ft. From here to Dry Creek the width varies from 12 to 20 ft. and the average grade is 9 ft. per mile.

At 23½ miles the canal is flumed over Dry Creek by a flume 70 ft. long and 12 ft. wide. From here the main canal continues about seven miles further on over the California Mesa, on which is the main body of the land to be irrigated. A large lateral twelve miles long leads off to the north towards the town of Delta, which is 21 miles from Montrose. The irrigated land reaches to within ½-mile of the depot at Delta. There are 18 miles of main laterals besides the 30½ miles of canal.

There are about 6,000 acres irrigated from the Montrose canal. Water is sold at $1,000 per cu. ft. for a perpetual right, or at $2.10 per miner's inch for yearly rental without buying a perpetual right. The latter seems to be the more popular method.

Notwithstanding the heavy first cost of the canal, many of the flumes have been rebuilt, as has been described, and large amounts have been expended on "The Slides." It reflects credit on the owners of the canal that, though it is obvious that the canal has not been a paying piece of property to them, owing to its high first cost and the expenses of operating, nothing has ever been spared to keep water running through to supply the consumers and to live fully up to all agreements regardless of expense.

The local superintendent of the Montrose canal is Mr. Edward Anderson, at Montrose. The general manager of this and other irrigation properties of the Travelers' Insurance Co. in Colorado is Mr. F. C. Goudy, of Denver. The present consulting engineer is Mr. Geo. G. Anderson, of Denver.

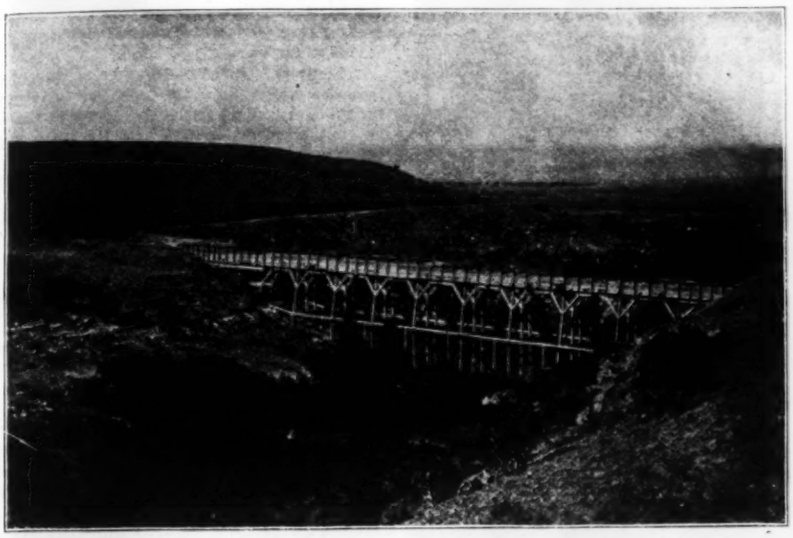

FIG. 3.—ORIGINAL FLUME OVER HAPPY CANYON, MONTROSE IRRIGATION CANAL, COLORADO.

in the winter of 1895-96. In constructing these, the timbers were framed and then well cooked in boiling coal tar before being put together. This should greatly prolong their life. Shortly beyond the Spring Creek flume a feeder from the creek empties into the canal, and a large ditch owned by other parties is also siphoned under it. At nine miles rock appears in the bottom of the ditch, and much of the excavation is in this material for the next six miles. At 10¼ miles is flume No. 5. This flume (about 300 ft. long and across a dry rocky gulch) was dispensed with in 1895-96 by running the canal line around the gulch. As this also crossed the gulch before heading it, a masonry retaining wall was built on the lower side. This wall is 270 ft. long, 14 ft. high above the foundations in the deepest place, 3 ft. wide on top, batters about 1 in 4, and is laid in Portland cement, of which nearly three car loads were used. The cost was about $3,000, while the cost of the excavation for the rest of the detour was over $5,000 more, much of it being in solid rock. The line is lengthened about 1,500 ft. by the change. Surveys have been made for detours around half-a-dozen other flumes beyond this, but none of them have been dispensed with as yet. Five of the flumes below No. 5 have been replaced by new ones. The extra fall given to the flumes will allow of sufficient grade being given to the detours, though they are usually three or four times as long.

The "rock section" extends from Mile Post 9 to the end of the 15th mile. The fall of the canal from the end of Mile 3 to the end of Mile 15 averages 3½ ft. per mile, and the width ranges all the way from 12 to 24 ft. At the lower end Lateral No. 2 is taken out. Here the "Big Drop" occurs. The water is turned loose down a gulch that drains into Coal Creek, and there is a fall of 175 ft. in the ½-mile. The water then runs down the rocky bed of Coal Creek for another five miles, falling

THE RAILWAY SYSTEMS OF CENTRAL AND SOUTH AMERICA.

(With full-page plate.)

Introductory.

The inauguration of the great Intercontinental Railway project in 1890 will doubtless be readily recalled by most of the readers of Engineering News. As planned, the scheme was to connect the principal countries of the two continents of America by a trunk line of railway some 10,300 miles long, of which over 5,400 miles were to be constructed. At that time, indeed, such was the powerful patronage with which the project was started, it did not appear so very incredible to many that this line would be built in the near future. Within a couple of years, however, the project dropped completely out of sight as far as the general public was concerned; and it was only by an effort of memory that even engineers recalled that a commission still existed and was ostensibly at work in the interest of the scheme. Such, however, was the fact; and this Commission has just published its final report, comprising seven thick quarto volumes, which traces the history of the project from its inception until the fall of 1898.

Briefly described, the work which has been done is to make a preliminary survey for the proposed line at a cost of $288,588, including the amount expended in printing the final report.

Despite the effectual manner in which time has buried the project for an Intercontinental Railway, a history of its inception, and of the work which the Commission has done in the field will, we think, be of interest to many. The surveys were carefully and intelligently conducted reconnoissances, and much of the information of various kinds developed by them is such as will appeal to engineers and others interested in the present and future railway development of Central and South American countries. In these respects the report is worthy of mention, and an abstract of its principal contents will be quite in place in these columns. In order that this abstract may be fully intelligible, we have replotted to smaller scale, or have reproduced in full, the principal elaborate general maps of separate countries, which the report contains. These maps show fully the existing and projected lines, and the new surveys which go to make up the route of the Intercontinental Railway as projected by the Commission.

Of the two classes of railways shown, however, the local lines already built are of considerably the most importance in the present status of the Intercontinental Ry. project. The information regarding these embraces the very latest facts obtainable upon the subject up to the time of the printing of the report. Regarding the maps which are reproduced direct in Figs. 1 and 3, it should be stated that they are not tracings of others already in existence, but were plotted direct by the Commission's engineers. The reports made by the field survey parties sent out by the Commission furnished the data for the belt adjacent to the line of the survey, but for other portions all known accessible maps and reliable authorities have been consulted. The map shown in Fig. 2 has been traced from an atlas map of South America to bring the scale down to a point where the map could be used in these columns.

History of the Intercontinental Ry. Commission.

In May, 1888, a bill passed Congress and was signed by the President, authorizing the calling of an International Conference of the American republics at Washington for the purpose of promoting closer commercial and business relations between them. The delegates of the several countries convened at Washington, D. C., on Oct. 2, 1889, and on Feb. 26, 1890, the Committee on Railway Communication submitted a report, in which it urged that "a railway connecting all or a majority of the nations represented in the conference will contribute greatly to the development of cordial relations between said nations and the growth of their material interests," and also recommended that "the best method of facilitating its execution is the appointment of an International Commission of Engineers to ascertain the possible routes, to determine their true length, to estimate the cost of each, and to compare their respective advantages." This report was taken up and advocated by Hon. James G. Blaine, the father of "Pan American" things in general, and through his advocacy the act making appropriations for the diplomatic and consular service of the United States for the fiscal year ending July 30, 1891, contained a provision appropriating $65,000 as the share of the United States towards preliminary surveys. The act also authorized the President to appoint the necessary engineer commissioners.

The Intercontinental Railway Commission, having thus been called into existence, began work on Dec. 4, 1890. After organization, the Commission turned its attention promptly to the main business of carrying out the preliminary surveys. The money available was $133,000, of which the United States had appropriated $130,000, and Chili $3,300. Argentina, Mexico and Uruguay declined to con-

tribute money toward the surveys, but proposed to complete the railways each in its own territory to connect with the Intercontinental line. It was decided that the finances would warrant the sending of only three corps of engineers into the field, although the Committee on Surveys had laid out work for six corps.

Organization of Surveying Parties.—It was planned that Corps No. 1, composed almost entirely of officers of the U. S. Army, under the command of Capt. E. S. Steever, U. S. A., was to proceed to Central America and survey a line from the western boundary of Mexico through Guatemala, Salvador, Honduras, Nicaragua, and Costa Rica; then through the Isthmus of Panama into Colombia until it should meet Corps No. 2 coming northward. Corps No. 2, under the direction of Mr. Wm. F. Shunk, was to proceed to Quito, Ecuador, and thence survey northward to Colombia, and through that republic and the Isthmus of Panama until it should meet Corps No. 1 coming from the north. Corps No. 3, under Mr. J. Imbrie Miller, was to proceed to Quito and thence survey southward through Ecuador and Peru to Lake Titicaca, on the confines of Bolivia.

As already stated, these three parties were the only ones actually dispatched to the field, but the scheme of the Committee on Surveys included three other parties which, if the finances permitted, were to be sent out at a later date. Corps No. 4 was to enter the field by the way of Antofagasta, Chili, and proceeding northeast, was to begin its surveys near the city of Oruro, Bolivia, working towards La Paz, Bolivia, and Puno and Cuzco, Peru, until it should meet Corps No. 3 coming southward. Corps No. 5 was expected to commence its surveys at Huanchaca, Bolivia, and work to the neighborhood of Potosi, crossing the river of Pilcomayo, entering Brazil by the way of Corumba and extending its surveys via Coxim until a connection should be made with the railways running to Rio Janeiro. Corps No. 6, commencing its work at Potosi, Bolivia, was to follow the course of the Pilcomayo River and proceed toward Asuncion, Paraguay, thus making connection with the railways of that republic and Uruguay.

The instructions issued to the surveying parties were that the general route laid out by the Commission should be followed, and that the surveys should be made sufficiently in detail to obtain "the data necesary for the preparation of a topographical map of the route and the location thereon of the lines selected, and for making a profile of the same." To this end notes were to be taken of: (1) The general topography of the regions traversed; (2) their general geological formation; (3) the nature of the soil, climatic conditions, and of the character of the agricultural and other industries; (4) the population; (5) the materials available for railway construction. The general route selected by the Commission was followed substantially as laid out, and is shown by the accompanying maps. After setting the surveying parties at work, the Commission took a final adjournment, first, however, appointing an Executive Committee, to which it delegated the necessary power and authority to carry to completion the work projected. Attention may now be turned to the information brought out by the work of the different surveying parties.

Work of Survey Party No. 1.

Guatemala.—The proposed line lies west of the Continental Divide. The peaks, generally volcanic, forming the crest of the divide, send out long, slender spurs toward the Pacific. These spurs rapidly decrease in altitude, and sink into the plain level before the coast is reached. Between these spurs are streams running almost perpendicularly to the seaboard, and, consequently, a railway whose general direction is from west to east must cross these spurs and streams nearly at right angles. A glance at the map shows the frequency of these streams.

The existing railway lines are shown by the solid lines on the map, and briefly described, they are as follows: Beginning at the open roadstead of Ocos, a narrow gage line has been built to Ayutla, between 12 and 15 miles distant, and an extension is projected to Coatepeque, and possibly to San Marcos. The next line in order proceeding east extends from the port of Champerico, via Caballo Blanco and Retalhuleu, to San Felipe, a distance of 41 miles, with a projected extension of 41.5 miles from Casa Blanca, 2 miles from San Felipe, via Zunil, to Quezaltenango. It is known as the Guatemala Western, and is a narrow gage road. From the port of San Jose the Guatemala Central R. R. is in operation to Guatemala City, a distance of 74 miles. From Guatemala City an extension is projected down the valley of the Rio de las Vacas, via Panajach, to Rancho de San Agustin, a distance of about 62 miles, the exact distance depending upon the route finally adopted.

Fig. 2.—Map of Northwestern Portion of South America, Showing Existing and Projected Railways and Route of Intercontinental Ry. Survey.

The surveys have been completed and some grading has been done. From Guatemala City to Panajach the elevation to be overcome is about 3,600 ft. in from 30 to 32 miles of line, but the remainder of the grades to Rancho de San Agustin are easy. At the latter place connection is made with the Guatemala Northern Ry., which is in operation to Puerto Barrios, 134.2 miles distant. Both the Guatemala Central and Guatemala Northern are 3-ft. gage lines. The former has a branch extending from near Masaqua to near Patulul, 33.3 miles. There is also built and in operation on the Atlantic slope a railway from Tecuru to Panzos, 22 miles long, and an extension has been projected to Coban, but its early construction is doubtful. The proposed links of the Intercontinental Ry. joining these lines are shown by the full lines on the map. Altogether 126.9 miles of new line would be required, at an estimated cost for masonry and grading of $2,210,919.

Salvador.—The physiography of the Pacific slope of the divide is much the same as that described for Guatemala. The principal river of the country is the Lempa. The principal existing roads built and projected are as follows:

The National Line is built and in operation from Acajutla, via Ateos, to Ceiba, a distance of 41 miles, whence a diligence run to Santa Tecla, from which a tramway extends to San Salvador, 7 miles. From Ateos the Santa Ana Ry. is built, via Sitio del Nino, to Santa Ana, a distance of 66.6 miles from Acajutla. There is also a branch now in operation from Sitio del Nino to Nejapa, 12.4 miles, whence a diligence runs to the capitol, 12 miles further. A portion of the line between Nejapa and San Salvador is under construction. From La Union to San Miguel, 20 miles, a line has been graded and 10 miles of track laid. A line is also projected from La Libertad to San Salvador, and surveys have been made for a line from La Libertad to Santa Tecla, upon which construction is to be soon commenced. The mountain sides are to be ascended by six switchbacks. The gage of all the railways of Salvador is 3 ft. The route of the Intercontinental Ry., in relation to these existing lines, is shown by the broken line, and as projected between Hachadina and Rio Guascoran, 166.8 miles of new line would have to be built, at an estimated cost of $3,987,634, for grading, masonry and bridges.

Honduras.—The portion of this country within the zone of the railway examination is in general flat, and offers few barriers to railway construction. "The Gulf of Fonseca is without question the finest harbor on the Pacific coast of America. Its extreme length is from 50 to 60 miles, and its average width about 30 miles. It contains a number of islands, is well protected, and its extent is such that it capable of sheltering the combined navies of the world."

The only railway of the country at present is the proposed interoceanic line from Puerto Cortez, via La Pimienta, Comayagua, La Paz and the valley of Guascoran, to La Brea or some other point on the Gulf of Fonseca. The first 30 miles to La Pimiento have been completed, and a branch is projected to Tegucigalpa. An American syndicate (Eng. News, Oct. 28, 1897) has charge of the construction of this line, whose gage will be 3½ ft. The proposed Intercontinental Ry. line from Rio Guascoran to Rio Negro is 71 miles, which is estimated to cost for grading, masonry and bridges, $1,108,697.

Nicaragua.—Taken together, the projected and completed railway lines of this country aggregate a considerable mileage. The only line in operation is the Nicaragua National Ry., which may conveniently be considered under three divisions, the western, central and eastern. The western division, from Corinto, on the Pacific, to Momotombo, 57.7 miles, is built and in operation. The central division is not yet constructed, but is intended to run from La Paz Junction, via Nagarote and Mateare, to Managua, 36 miles. At present communication between Momotombo and Managua is maintained by means of steamers on Lake Managua. The eastern division, from Managua to Granada, 32.6 miles, is in operation. A branch of the National line, from Masaya to Diramba, 20 miles, is under construction, and 9 miles were completed in July, 1897, and the remainder was to be completed within a year from that date. The gage of all these lines is 3½ ft.

Among the projected lines of Nicaragua is one from San Juan del Sur to San Jorge, on Lake Nicaragua, 22 miles, with a branch from Chinandega to El Vejo, from four to five miles long. To bring the central portion of the Republic into communication with the departments in the northeastern section, a road has been projected from Momotombo, via Sebaco and Matagalpa, to a point on the Rio Grande. The distance to Matagalpa is between 90 and 100 miles, and to the Rio Grande from 240 to 250 miles. This is called the Northern R. R., and is estimated to cost $10,000,000, as several mountain ranges, some of them 3,000 ft. high necessitating heavy grades, will have to be surmounted. A more feasible project is that known as the Atlantic, or Rama, railway, which is projected to run from the port of San Ubaldo, on Lake Nicaragua, to the city of Rama, 102 miles. In order to make it a through line, an extension along the northeastern shore of Lake Nicaragua, to connect with the National line at Sabana Grande, has been proposed, the total length of the main line and extension being 220 miles. This route has been examined by competent engineers, and its feasibility demonstrated. The Intercontinental Ry., from Rio Negro to Pena Blanca, as shown by the broken line, would be 209.7 miles long, of which 103.4 miles, between Chinandega and Granada, may be considered as practically finished.

Costa Rica.—The rugged nature of the Pacific slope, with its long mountain spurs and intervening valleys and streams, is more noticeable here than in any of the countries so far mentioned.

excepting, possibly, Guatemala. The mountain spurs, however, extend down much nearer the coast than in Guatemala, many of them terminating in abrupt promontories.

There are but two railways in operation in Costa Rica, of which the most important by far is the Atlantic Ry., running from Puerto Limon to Alajuela, 117 miles, with a branch from Siquirres to Carrillo, 25 miles. From Carrillo an extension has been projected, via Muella and the valley of the Rio Frio, to Fuerta de San Carlos, a distance of 25 miles. This extension has been carefully surveyed, and is believed to possess many advantages as a connection between Lake Nicaragua and the Caribbean Sea. Its approximate length would be 100 miles. All the road so far built has a gage of 3 ft. 6 ins. The second railway of Costa Rica is an unimportant, narrow gage line, 13 miles long, between Punta Arenas and Esparta. It was originally the intention to extend this line to Alajuela, where connection would be made with the Atlantic Ry., but more recent studies have indicated another route as being preferable, namely, that commencing at San Jose and following the valley of the Rio Grande to the plains of Santo Domingo, and thence turning towards the northwest to Punta Arenas, a distance of about 62 miles. The route of the Intercontinental Ry., from Pena Blanca across Costa Rica, hugs the coast closely. The distance to Rio Golfito is 360 miles, all of which would be new line.

FIG. 4.—JAMBELI BRIDGE ON NATIONAL ROAD, 25 MILES SOUTH OF QUITO, ECUADOR.

The foregoing covers the investigations for the Intercontinental Ry. in Central America. Briefly summarized, the total distance from Ayutla across Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica to Rio Golfito, is 1,043 miles, of which 211.3 miles are practically constructed, leaving 831.7 miles to be built, at an estimated cost for grading, masonry and bridges, of $17,154,517.

Work of Survey Party No. 2.

The two sections of territory covered by the surveys of Corps No. 2 were surveyed in opposite directions—the southern portion, from the south northward, and the northern portion, from the north southeastward—but for the purpose of summary it will be better to consider the line as running continuously from north to south. As a matter of fact, the work of Corps No. 1 did not extend clear to the Rio Golfito, but only as far as the Rio Savegre, where Corps No. 2 took up the survey. The engineer in charge of this party was Mr. William F. Shunk.

Colombia.—The western section of this country is a series of parallel mountain ranges, separated by the valleys of the Rio Magdalena, Rio Cauca and Rio Atrato. Following the western coast of the Isthmus of Panama the Intercontinental railway line takes the valley of the Rio Cauca south. At present the main artery of commerce of the country is the Magdalena River, and nearly all the railway lines heretofore constructed have been built to connect the more important centers of trade and population with the waters of this stream, which, however, is navigable by vessels of small draft only, having a very swift current and also steep rapids near Honda.

The railway across the Isthmus of Panama was the first one constructed south of the Rio Grande, and, as is generally known, was begun in 1850 and completed in the same year, at a cost of $7,500,000 for 47.5 miles of line. The Cauca Ry. starts at the Pacific seaport of Buenaventura, and, ascending the valley of the Rio Dagua, is completed to a point beyond San Cipriano, about 25 miles. Surveys have been made, and some construction has been done on an extension to the town of Cali, in the fertile Cauca Valley. The Antioquia Ry. is designed to connect Puerto Berrio, upon the Magdalena River, with Medellin, the capital of the Department of Antioquia, the distance being 125 miles. Only the lower portion of the line from the river to the town of Pavas, about 31 miles, has been finished. This road is in poor condition, and not equal to the present demands of trade. The Cartagena Ry., from Cartagena to Calamar, 60 miles, and the Bolivia Ry., from Puerto Colombia to Barranquilla, 18.5 miles, are in operation. The Santa Maria Ry. is under construction, with about 37 miles in operation, from Santa Maria, on the Caribbean Sea, to Banco, on the Magdalena River. The Cucuta Ry. was from Villamizar to San Jose de Cucuta, a distance of 34 miles. The Doruda Ry. extends from Las Yeguas, at the head of navigation on the Rio Magdalena, to Arrancaplumas, near Honda, a distance of 14 miles. The Girardot Ry. runs from the town of that name up the valley of the Rio Bogota, and is completed to Juntas de Apulo, a distance of 25 miles. It is the intention to extend this line to Bogota. From Bogota the Sabana R. R. is in operation for a distance of 26 miles to the town of Facatativa, and it is intended to extend the line to the Rio Magdalena, at some point in the neighborhood of Ambalema or Honda. The Zipaquira Ry. extends from Bogota to Chapinero, a distance of 4 miles. The original intention was to continue the road to the town of Zipaquira, the center of an important salt mining industry, but there is no prospect of an early completion of this extension. There is also a railway under construction between Bucaramanga and Puerto Wilches, on the Rio Magdalena, and another is being built between Girardot and Ibague. These comprise all the lines completed, and actually under construction, although several concessions for roads of more or less importance have been granted.

The route of the projected Intercontinental Ry. is along the western coast of the Isthmus, and thence south through the valleys of the Rio Sucio and Rio Cauca, with a branch from near Paso de Caramanto, north to Cartagena. The total distance from the Rio Golfito to the Rio Carchi is 1,354 miles, exclusive of the Cartagena branch, and the average estimated cost for grading, masonry and bridges is $24,917 per mile of line. For the purpose of connecting the main line along the Cauca River with the Magdalena valley and Bogota, two routes over the Cordillera Central were more or less examined. The first of these was from Cartago to Ambalem, 130 miles, and the second was from Popayan to La Plata, 100 miles. Briefly summarized, the total distance from Ayutla, on the Mexican border of Guatemala, to the Rio Carchi, near Iplales, is 2,397 miles, of which 211.3 miles are built, and 2,185.74 miles would have to be constructed, at an estimated cost for grading, masonry and bridges, of $50,892,941.

Work of Survey Party No. 3.

The task allotted to Corps No. 3 was to survey the line from Quito, south through the principal central towns of Ecuador into Peru, and after striking the Maranon River, in the northern part of the latter republic, to follow its valley to its headwaters near Cerro de Pasco, and thence proceed southeast towards Cuzco and onward towards the confines of Bolivia. This party was in charge of Mr. J. Imbrie Miller until the surveys reached Loja, when Mr. W. D. Kelley acted as engineer in charge, owing to the illness of Mr. Miller.

Ecuador.—Although its surface is very diversified, this country does not present the jumble of mountain masses which is found in certain other parts of South America, but rather a well-defined system. Running from the northeast to the southwest, through the center of Ecuador is an elevated region, situated between two ranges known as the Oriental and Occidental Cordilleras, which are in general from 30 to 60 miles apart. Although the axes of these two ranges are not straight, but curved lines, in certain parts there is more or less of a parallelism to be noted. Outside of the main ridges there are projecting spurs extending east toward the Amazon River, and west toward the Pacific Ocean, and the two ranges are more or less closely connected by transverse ridges, which by the natives are called nudos, or knots. These divide the central valley into ten or more compartments, varying in length, breadth and elevation, and it is the passage of these cross ridges within the limits of a suitable alinement and grades that present difficulties to the locating engineers. The floors of these basins vary from 7,000 ft. to 10,000 ft. above the sea in the north, and the dividing ridges at their lowest points attain altitudes of from 9,300 ft. to 11,500 ft., but become considerably lower in proceeding south. Nearly three-fourths of the population of the country is contained in this central valley or zone.

The only railway in operation in Ecuador is the Ferrocarril del Sur, running from Duran, a town opposite the porte of Guayaquil, to Puente de Chimbo, and north. The length of the road in operation is between 55 and 60 miles, and the intention has been to extend from Chimbo, via Sibambe, to the neighborhood of Tigsan, and, ultimately, to continue the line northward across the interior basins to Quito. Some grading has already been done between Chimbo and Tigsan, and, according to recent information, proposals have been invited by the Ecuadorean Government to complete the line to the capitol. The distance between Chimbo and Sibambe is only 15 miles in a direct line, but the difference in elevation to be overcome is said to be 7,727 ft., requiring a lengthy development and heavy grades. Several other lines have been proposed, but no work has been done upon them. Among these is a railway from Esmeraldas, on the Pacific, to the capital, one from Bahia to the same point, and one from Machala to the neighborhood of Cuenca and Azogues, which have been considered as possibilities. The Southern road, however, is the only one which gives promise of completion. The route of the Intercontinental Ry. across Ecuador, from Rio Carchi to the Rio Canchis, is 658 miles, and the work is estimated to cost $40,827 per mile.

Peru.—The railways of Peru are quite notable. Beginning at the seaport of Paita, there is a line in operation up the valley of the Chira to Sullana, and thence to Piura, a distance of 62 miles. Private parties have recently extended this to Catacaos, a distance of 6 miles. From Eten and Pimentel, on the coast, there are short lines to the cities of Lambayeque, Chiclayo and Ferrenafe, a distance of 50 miles. The Pacasmayo road, starting from the port of that name, ascends the Rio Jequetepeque to Yonan, with a branch to Guadalupe, the length of the line in operation being 66 miles. Extensions are proposed to Cajamarca and

Hualgayoc. There is also a short line from Salaverry through Trujillo to Ascope, 53 miles. Proceeding southward the next railway in order is the Chimbote line, which ascends the Rio Santa, and is completed to Suchiman, a distance of 30 miles. The intention was to continue this line to Huaraz and Recuay. The famous Oroya Ry., built by Henry Meiggs, comes next in order. It extends to Oroya on the Janja River from Callao, a distance of 136.5 miles, and is substantially constructed. From Lima a short line runs southward to the watering place of Chorillos, a distance of 7 miles. It has been the intention to extend the Oroya Ry. to Cerro de Pasco. There is now a short local line in operation between this point and Sacra Familia, a distance of 9 miles, used solely for the purpose of the silver mining operations in that region. A 48-mile line runs from Pisco, on the coast, to Ica, and a proposition has been made to extend it to Lima.

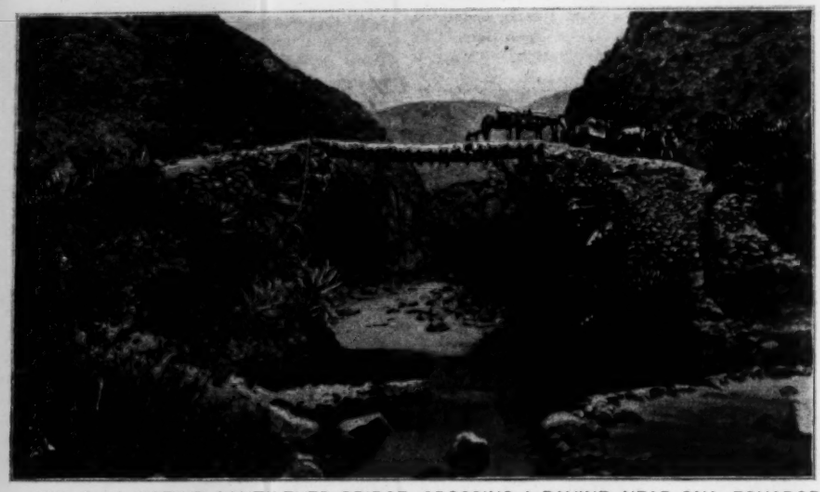

FIG. 6.—A NATIVE CANTILEVER BRIDGE CROSSING A RAVINE, NEAR ONA, ECUADOR.

The longest line in operation in Peru is that which starts at the port of Mollendo and, running via Arequipa, crosses the Continental Divide at an elevation of 14,665 ft. at the Portezuela del Crucero, thence proceeding via Juliaca it reaches Puno, on Lake Titicaca, the altitude of this town being 12,540 ft. From Juliaca a branch line has been built via Santa Rosa to Sicuani, in the direction of Cuzco. The distance from Mollendo to Puno is 325 miles, and from Juliaca to Sicuani is 122.4 miles. Surveys and estimates have been made to extend the line from Puno along the shores of Lake Titicaca, via Desaguadero, to La Paz, in Bolivia. To descend from the plateau to the town of La Paz, two systems have been proposed; one an inclined plane, 8,202 ft. long, dropping 1,410 ft., using the Ogudio system (rack and rope), at a cost of $170,327; the other a rack road of the Abt. system, with 15% grades, the length being 15,092 ft., and the fall 1,329 ft., costing about $369,854. The distance from Puno to Desaguadero is 102.53 miles. There appears to be no probability of the immediate completion of the road from Sicuani to Cuzco, a distance of 86.37 miles, as the traffic is not sufficient to warrant the outlay.

The route of the Intercontinental Ry., as surveyed to Cuzco, is shown sufficiently by the map. The total distance to that city from Quito is 1,944 miles. The railway lines built and projected between Cuzco and Desaguadero have already been described. To summarize the total distance from Ayutla to Desaguadero is 4,840 miles, of which 362.9 miles are constructed, and 4,447 miles remain to be built, at an estimated cost of $143,514,942 for grading, masonry and bridges.

In concluding this review of the railway system of Peru it may be mentioned that a proposition has been made to extend the Pacasmayo R. R. to Borja, on the Maranon, whence water communication along the Amazon would give access to the Atlantic Ocean. In addition, instrumental examinations have been made of the route from Oroya, via Tarma, near the head of the Chanchamayo River, to the head of navigation on the Perene, with the same object in view.

The Southern South American States.

While the investigations of the Commission's surveying parties extended no further south than Cuzco, its report includes the countries of Bolivia, Argentina, Paraguay, Uruguay, Chili and Brazil. Of these the railway systems of all except Bolivia and Brazil are rather noteworthy, that of Argentina being particularly so, and are worthy of some extended description. The map, Fig. 3, of these countries, is reproduced direct from that in the Commission's report. This map shows the general physiography of the territory so fully that no description is necessary.

Bolivia.—The only railway in actual operation in Bolivia is the narrow gage (75-cm., or 29.52-in.) line, which, starting at the Chilian part of Antofagasta, climbs the Pacific slope of the Andes by the way of Calama and crosses into Bolivian territory near Ollague, north of Ascotan, and thence proceeding through Uyuni and Challapata, skirts the eastern borders of Lake Poopo and terminates at Oruro, distant 574 miles from Antofagasta. There is a short branch 20.3 miles long, connecting Uyuni with Pulacayo, thus affording access to the important silver mines of Huanchaca. It is the intention to extend the main line northward to La Paz in order to put this last point into direct communication with the Pacific coast at Antofagasta, and thus divert some of the trade that now goes to Mollendo by the steamers on Lake Titicaca and the Mollendo, Arequipa & Puno railway in southern Peru. The proposed extension from Oruro to La Paz has already been surveyed and construction has been commenced. The distance is 155 miles.

Surveys have been made eastward, from Challapata to Colquechaca, Sucre and Potosi, the distance to Colquechaca being 62.14 miles, and to Sucre 76.43 miles further. The officers of the Arequipa & Puno Railway have made surveys to extend their line to La Paz, the line being divided into two sections; the first between Desaguadero and the plateau overlooking La Paz would be 66.52 miles in length, and would cost $1,313,955. For the second section, comprising the descent to the town, two solutions are proposed, as already described in the paragraph on Peruvian railways.

It is proposed to build a railway from La Paz via Corocoro to the city of Tacna, where connection would be made with the Arica Ry., already in operation, the distance between the two last-named points being 39.15 miles. This would be the shortest route to the Pacific coast, but would involve some very difficult work in surmounting the Andes, the distance from La Paz to Tacna being 294 miles. At present much of the commerce between Bolivia and the outside world is conducted over this route by means of mules, burros and llamas. Surveys and estimates have been made for a railway by the Abt system from La Paz eastward and northward through the rich province of Yungas to the head of navigation on the Beni River, the distance being from 93 to 124 miles, and the estimated cost $3,893,200. In southern Bolivia investigations have been made to extend the railway from Uyuni to Tupiza, 119 miles, and thence to Quiaca, on the Argentine frontier, a further distance of 55.9 miles. At Quiaca one is within 125 miles of Jujuy, at present the northernmost terminus of the Argentine railway system.

Concessions have been granted for a railway from Oruro, through Cochabamba to Trinidad, also from Cochabamba to Santa Rosa de la Sierra, and thence to Puerto Pacheco, on the Paraguay River; likewise another for the extension of the Paraguayan and Bolivian standard gage line from Asuncion to Sucre. This is known as the Osborn concession; and a proposition has been made to continue the line, via Oruro, La Paz and along the eastern shore of Lake Titicaca, to Santa Rosa, in Peru, where connection would be made with the Southern Ry. of that republic, in operation northward as far as Sicuani.

Argentine Republic.—The railway system of this country is the most extensive of any in South America, and only a brief mention of some of its more important features can be made here. In 1857 there were just over six miles of railway in the country, and in 1892 there were 8,071, which has been added to considerably since. The first railway which should be mentioned for its importance is the Buenos Aires & Rosario Ry. This line has a gage of 5½ ft., and extends from Buenos Aires, through Rosario to Tucumán, a distance of 717 miles. This, in connection with the Central Northern Prolongation Ry., with a gage of 3¼ ft., carries railway communication to the town of Jujuy, 936.66 miles from Buenos Aires. The second notable line is the Transcontinental System. The first link in this line is the Buenos Aires & Pacific Ry., of 5½ ft. gage, running from Buenos Aires to Villa Mercedes, 430 miles. At the last point connection is made with the Argentine Great Western Ry., having the same gage and extending to Mendoza, a distance of 221 miles, with a northern branch open to San Juan, a further distance of 97.87 miles. At Mendoza junction is made with the 3¼-ft. gage Transandine Ry., which is being built to the Argentine frontier, a distance from Mendoza of 107.81 miles, where connection will be made with the Chilian section of the same road. According to the latest reports, the Chilian section was completed eastward as far as Salto de Soldado, there being a gap between that point and the Argentine terminus at Punta de las Vacas of 46.6 miles. Under the concession granted by the Chilian Government in 1895 the excavation of the numerous tunnels of this line is gradually approaching completion. The other railway lines of Argentine, Chili and the republics east of them, as well as the most important projected lines, are shown by the map, Fig. 3.

As a matter of record, the length of the Intercontinental Ry. and its estimated cost in the various countries through which it passes, have been summarized in the accompanying table. The route of the line is shown by the solid and dot and dash lines on the maps, Figs. 1, 2 and 3. The hatched lines on these maps show the existing railways constructed and in operation, and the broken lines

Table Showing Termini, Distances and Cost of Construction of Different Sections of the Proposed Intercontinental Railway.

Country.	From	To	Miles. Built.	Miles. Proposed.	Miles. Total.	Cost.
Guatemala	Ayutla	Hachadura	43.9	126.9	170.0	$2,210,919
Salvador	Hachadura	Rio Guascoran	64.0	166.8	230.0	3,987,634
Honduras	Rio Guascoran	Rio Negro	..	71.7	71.7	1,108,697
Nicaragua	Rio Negro	Pena Blanca	103.4	196.3	299.7	1,506,350
Costa Rica	Pena Blanca	Rio Golfito	..	360	360	8,340,917
Colombia	Rio Golfito	Rio Carchi	..	1,354	1,354	33,738,424
Ecuador	Rio Carchi	Rio Canchis	..	658	658	26,863,855
Peru	Rio Canchis	Desaguadero	151.6	1,633.9	1,785.5	65,758,146
Bolivia	Desaguadero	Quiaca	195	392	587	.....
Argentine	Quiaca	Buenos Ayres	936	125	1,061	.....
Total	Ayutla	Buenos Ayres	1,283	4,163	5,446	.....

show the projected roads and extensions. Figs. 4, 5 and 6 are views of bridge structures in Ecuador, which exhibit perfectly the extremes in the art of bridge construction which may be found in the countries which it was proposed to open up by the Intercontinental Ry.

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Increase of steam pressures brings properly a demand for the very best material with which to construct boilers. Reliability is the desideratum, as no element of the construction can be defective without imperiling the whole, and with it jeopardizing the lives of those in charge of the plant.

Of late years, and indeed ever since mild steel set out to replace wrought iron, there has been continuous and rapid progress in the art of manufacturing this material, until any desired quality can be uniformly produced by the most careful makers.

Undoubtedly, the government inspections and the tests that have been imposed by the Bureau of Steam Engineering of the U. S. Navy Department, for all materials before acceptance, has wonderfully assisted in the advances in the art of steel producing in this country. It has stimulated a beneficial rivalry that has resulted in almost entirely eliminating the elements of unreliability and non-uniformity from the forged steel of to-day, and even with cast steel there is to-day little left to criticise.

Comparatively recently nickel steel, which has for years been extensively used in armor, has been attracting considerable notice as being most admirably adapted to parts of boiler work, especially to bracing and rivets, and through the patriotic interest of some of our manufacturers we have had tests made which are as valuable as they are interesting. One of these series of tests† was with nickel steel rivets, which gave a tensile strength of over 75,000 lbs. per sq. in. and an elastic limit of over 40,000 lbs. Such material as this enables designers to use much smaller rivets, thus cutting away much less of the original plate. These rivets also have quite a fair range of heat at which they can be safely driven, the precaution being not to go above a bright cherry red. They also proved to be tougher and freer from the brittleness of heads formed by sledge and cup sets, which sometimes appears with common steel rivets.

Nickel steel for boiler braces and rods possesses a superiority quite as definite as with the rivets. Chemical analyses give: Carbon, 0.23; sulphur, 0.017; manganese, 0.61; nickel, 3.22; and phosphorus, 0.021. Its average tensile strength is over 80,000 lbs. per sq. in., with an elastic limit of 55,000 lbs. per sq. in. and an elongation of more than 23% in 8 ins., with a reduction of area of 55%. It is very uniform and exceedingly reliable. When subjected to a drop test it tears a grain at a time, holding together for many blows after fracture begins. In several cases where bars of this composition 4 ins. in diameter were tested by dropping a weight of 1,640 lbs. upon them from a height of 44 ft., the bars being supported at their ends only, and after each drop the bars were turned over to put the convex part of the resultant bend always uppermost, it required 40 blows of this nature before fracture began, and 40 additional blows to complete the break.

Government naval specifications for boiler materials for 1898 are much more rigid than for any previous year. Take for example the single factor of tensile strength of shell plates. In 1897 the ultimate limits were 58,000 and 67,000 lbs., with an elastic limit of at least 32,000. In 1898 these limits were raised to 74,000 lbs. and 82,000 lbs., with an elastic limit of 40,000 lbs.

Specifications for boiler materials for 1898 require open-hearth steel plates showing not more than 0.035% of phosphorus or 0.03% of sulphur. There are three grades of plates:

	Tensile strength.	Elastic limit.	Elongation in 8 ins.
Class A, No. 1	74,000 to 82,000	40,000	21%
" " 2	66,000 " 74,000	36,000	23%
" " 3	60,000 " 66,000	32,000	25%

There are also the usual requirements regarding surface and other defects, and only the cold bending test is used.

Allowable variations of weight and gage are as follows:

	Weight, per cent. Above.	Weight, per cent. Below.	Gage, below, in.
Plates more than 110 ins wide..	7	2	0.06
" from 100 to 110 ins. wide	6	2	0.05
" " 80 " 100 " "	5	2	0.04
" " 60 " 80 " "	4	2	0.03
" less than 60 ins. wide..	3	2	0.02

Boiler Braces.—These are of open-hearth steel of same chemical composition as boiler plates annealed as a final process, and the test requirements call for:

	Tensile strength, per sq. in.	Elastic limit.	Elongation, per cent. 8-in. piece.	Elongation, per cent. 2-in. piece.
No. 1	74,000	40,000	22	26
No. 2	66,000	36,000	24	28
No. 3	60,000	32,000	26	30

Three cold bending tests are required, one for each grade, using a bar ½-in. thick, the ends being brought parallel, using radii of 1-in., ½-in. and a flat fold.

In addition, there is an opening and closing test requiring angles, T-bars and other shapes to stand opening out flat or closing down face to face.

Fig. 1.—Steel Steam Pipe, with Welded Flange; Section Removed and Bent to Show Perfect Weld.

Rivet Rods and Finished Rivets—May be of two classes, high-grade, Class A, with the same chemical composition as boiler plates, and Class B, made by the open-hearth or Bessemer process. The tensile requirements of these are:

	Tensile strength, lbs. per sq. in.	Elastic limit.	Elongation in 8 ins.
Nickel-steel	75,000 to 85,000	40,000	23%
Class A.	60,000 " 68,000	32,000	26%
Class B.	54,000 " 62,000	30,000	29%

In addition both cold and quenching tests are required. Also a hammer test of finished rivets, in which specimens must stand flattening cold to a thickness of half the original diameter, and a hot test to one-third the original diameter.

The specifications for various forms of tubes used were given briefly in Engineering News for Jan. 9, 1899. It might be stated in addition that all tubes must stand an internal hydrostatic pressure of 1,000 lbs, and if the tube

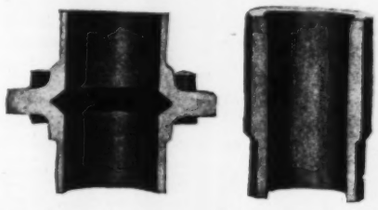

Fig. 2.—Spun Flanges for Steel Steam Pipes, Showing the Upset End Before Spinning and Section of Finished Joint.

ends are flanged, swedged down, swelled, upset or reinforced, they must be tested after the process.

Boiler tubes, fittings and steam and water pipes are now, of course, subjected to increased pressure, and are objects of as much concern regarding their trustworthiness and perfection as is the boiler proper. Steel is the material for these parts best adapted to the conditions.

In the advances of seamless-drawn pipe making, it has become possible to make both T's and crosses in this manner. As these are necessarily of the very highest grade steel, the advantages they possess over the bulkier and less reliable castings usual to such forms are obvious, and especially for the express type of boiler work where reduction of weight, provided it does not decrease strength or reduce longevity, is most desirable.

Great improvements have been made in the method of obtaining excellence in the matter of pipe flanges for high pressures, and the results up to the present time have been not only highly satisfactory, but embrace features of novelty and interest as well. With the adoption of steel for high-pressure steam pipes came the necessity of making sure that defects should not develop in the flanges. Not only is the element of danger one to be thus guarded against, but also the issues of economy which are so seriously damaged by leaky joints. The flanges must be substantial, and heavy enough to permit of properly making and holding the junctions of sections and preserving the integrity of the system, and at the same time they must be as nearly a portion of the pipe itself as is possible to make it. Hence the superiority of a perfectly-welded flange over the old brazed and riveted flanges of our lower-pressure copper pipes, or the riveted and calked flanges of wrought-iron pipes. Fig. 1 shows how perfectly this work of welding flanges is now done; and it is applied equally readily to pipes of 1 in. and as high as 30 ins. in diameter. Also there is no necessity of the metal of pipe and flange being alike, as an iron flange can be welded either to a steel or iron pipe. These flanges are cut from a solid plate.

The test here shown was made by cutting a section for a selected pipe as shown in the figure and bending the strips of pipe parallel to face the flange, the bend being in the weld. The perfection of the weld is thus clearly shown, and with a seamless-drawn pipe and a solid-cut flange there is little room to criticise the result in points of either solidity or finish.

The thickness of pipe desired in order to make the weld properly is given as follows: 2-in. pipe should be No. 6 B.W.G. thick; 4-in. pipe should be No. 4 B.W.G. thick; 5 and 6-in. pipe should be ¼-in. thick; 8-in. pipe should be 5-16-in. thick. Pipes can be solid drawn up to 8 in. diameter.

In the matter of flanging, however, there has been produced a more remarkable result than the above with low-carbon steel of finest grade, following the lines of "spinning" the metal. This is shown by the samples in Fig. 2. The lower piece represents a heavy "upset" 2 ins. long on a No. 8 B.W.G. seamless-drawn boiler tube. The upset end was then swelled, cold, with a taper mandrel, and being placed in a special machine, resembling a lathe, was rapidly revolved, while a former was, by special hydraulic machinery, pressed steadily and powerfully against the expanded end until the metal was heated and spun into the general shape of a flange. It was necessary to cut only ¼-in. from the edge of this flange to remove absolutely all indications of fraying or cracks, and then the flange end was trued up to give it the finished appearance shown in the upper piece in the figure.

A powerful machine is now under construction by which this character of work will be applied to pipes up to 8 ins. outside diameter, which includes all the sizes of steam and water pipe now used in torpedo boats and destroyers building for the government. A series of tests is now being made on these flanges, using high-grade nickel-steel bolts, to determine just what pressure the flanges will stand. The thickness of flange necessary for each size of piping will be practically determined, and each piece will be tested to rupture, to locate the weak points in the design.

A MACHINE FOR BREAKING UP CONCRETE.

We illustrate herewith an ingenious apparatus which has been rigged up in Los Angeles by a firm of contractors to break up the concrete between the yokes of the old cable railway. Electric traction replaced the cable some time ago, and it has been found necessary to lay new and heavier rails on some of the lines. The machine shown in the cut was briefly described by a Los

Machine for Breaking Up Concrete Around Cable Railway Conduit, Los Angeles Street Railways.

Angeles correspondent in our issue of Feb. 2, p. 76. It consists, as will be seen, of an ordinary pile-driver frame, mounted on rollers and with a special hammer having a chisel edge on its lower side. The power to operate the machine is furnished by an electric motor taking its current from the trolley wire. The machine breaks up from 320 to 350 ft. of track per day.

We are indebted to the courtesy of Mr. R. G. Miller, of the engineering firm of Skinner & Miller, of Los Angeles, for the photograph from which our illustration is reproduced, and for the particulars concerning its operation given above.

*Abstract from an article in the Journal of the American Society of Naval Engineers for February, 1899.

†Journal of the American Society of Naval Engineers, November, 1898.

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The report of the Intercontinental Railway Commission, which we abstract as regards its principal technical features in another part of this issue, recalls to mind what was without doubt the most chimerical of all the schemes promulgated by the nearly forgotten Pan-American Congress of ten years ago. Probably no well-informed engineer ever took very seriously this fantastic project to connect all the American republics on the two continents by a government railway; but it was at its inception pushed with such energy by a few active Congressmen and Cabinet members that it certainly came to be regarded by many people as a really meritorious enterprise, whose early consummation was not only desirable but entirely probable. This idea was greatly encouraged by the prominence given by the daily papers to the deliberations of the Commission and to the final dispatching of its surveying parties into the wilds of Central and South America. As some of these papers are now trying to revivify the scheme it may be well to point out again some of its absurdities, which were obvious at the beginning and which the surveys have served to bring out more plainly.

The cost of the enterprise to date and the amount of valuable work which those in charge of it have to show for this expenditure first deserve notice. During its eight years of existence the Intercontinental Railway Commission has spent $292,452, according to its own showing, of which $192,734 was spent in making the surveys, $65,910 was consumed in office expenses, and $33,808 was the cost of printing the present report. Of this sum the United States contributed about $195,000 in cash and the printing expenses, Brazil contributed $30,000 in cash, and six other Central and South American countries the balance. Argentine, Mexico and Uruguay have lent an encouraging countenance to the work, but, it is refreshing to note, have kept a close grasp on their purse strings. Its surveys are about the only work of the Commission which has served some useful purpose. They were, in general, fairly good reconnoissances of the territory adjacent to the proposed railway line and give a good deal of interesting information regarding the physical geography, natural resources, people, and railways and other means of communication of the countries visited. In these respects we are glad to recommend the report of the Commission as a useful publication.

As far as an intercontinental railway line is concerned, the surveys also show that to complete an all-rail route connecting the United States with the Latin-American republics as proposed there must be built some 5,400 miles of railway the cost of which, for grading and masonry alone, is estimated by the Commission at $175,000,000. All equipment and practically all structural material, including tools, cement, and even timber in many instances, must be shipped into the country from the United States. It is probably a conservative figure, therefore, to add from 25 to 30 per cent. to this sum for track, buildings and structures, rolling stock, and the general line and station equipment necessary to put the new railway in shape to begin operation. This does not include some 10 per cent. for interest on bonds, taxes, office expenses and salaries up to the time of opening the line for business, which would have to be added to the expenditures of a private company building a railway in the United States, but most of which, it is reasonable to presume, a government enterprise would escape. The 5,400 miles of new line when built would form a series of links connecting isolated narrow gage railways, which in Central and South America would aggregate about 1,500 miles, all of which would have to be made capable of carrying standard gage rolling stock, probably by adding a third rail. The reader can supply his own figures of the cost of these changes. To sum up, there would finally be a railway line which would not only parallel the ocean routes, but which would actually be much longer from port to port than these ocean lines, and which runs for much of its length south of Mexico through countries with a sparse and semi-civilized population and almost no industries. It is perfectly certain that private capital could never be induced to invest in such a line of railway under such conditions; and no one who takes a reasonable view of the proper functions of government could favor its engaging in such an enterprise, promising neither direct nor indirect profits.

During the past month public opinion in New York city has been greatly exercised over what is commonly called "the Amsterdam Avenue grab." Briefly stated, the condition of affairs is this: Amsterdam Ave. is one of the finest of the north and south avenues on the upper West Side of New York city. It is lined with handsome residences, and along it are located such institutions as Columbia University, St. Luke's Hospital, and the site of the new Cathedral of St. John. At present there are four lines of street railway track upon this avenue, the two inner ones owned by the Metropolitan Street Ry. Co., and the two outer ones by the Third Avenue R. R. Co. The Metropolitan tracks were changed last year to the underground electric system. It is now proposed to change the two outer tracks on which horse cars are now run to the electric conduit system; and the entire population of the upper West Side is up in arms to prevent it. Failing relief from the New York city authorities, the fight has been carried to the New York legislature, and is there being waged with such intensity as to exclude other and perhaps equally important subjects from public consideration.

We hope those who are fighting against the introduction of four parallel electric railway tracks upon the surface of Amsterdam Ave. will win. It is certainly an outrage and a crime against public safety to place four parallel lines of rapidly moving electric cars upon any street in a crowded city. And yet, at the same time, we are constrained to say that the people of New York are merely reaping the legitimate fruit of what they have sown. They protest, and with reason, against the final act of changing the outer pair of tracks to the electric system; but where was the protest that should have been made when it was first proposed to lay two additional tracks for horse car service? The surface of no city street, except under the most exceptional circumstances, ought ever to be obstructed by more than two street railway tracks; yet through ignorance or neglect, or worse, on the part of the city authorities, two companies were each allowed to lay double tracks along the whole length of this magnificent street.

The excuse when it was done, was that it would benefit the public by securing the benefits of competition; but the absurdity of this plea ought to have been evident. It was known at that time that competition in the street railway business was a delusion. No permanent competition can be established in street railway service, and to attempt to inaugurate it interposes burdens on the taxpayers, causes needless waste and needless obstruction of the streets, while securing not a single public benefit in the shape of reduced fares or better facilities that might not better be secured in other ways.

We are impressed with the fact that the vast amount of public sentiment which has been aroused over the Amsterdam Ave. grab, as it is called, is demanding far less than it ought to demand. It is fighting the Third Avenue Company's proposal to change its motive power to electricity, but it ought to demand something more than the mere prevention of the concluding act in a series of aggressions upon the public rights. Public sentiment ought to be aroused to the consideration of other streets and other acts of corporate aggression than the single one on Amsterdam Ave. Sooner or later cities must be given power to undo the mistakes of the past in the granting of franchises to private corporations. It is not just that the ignorance, or carelessness, or corruption of a single set of city officials should bind all succeeding generations.

Again, it is absurd that a city should permit the extensions of the system for the carriage of passengers in its streets to be made only through the initiative of private corporations. Why should street railways be built only when and where it suits the pleasure of street railway officers? It is well understood, nowadays, that the furnishing of proper street railway facilities is as essential to the welfare of a city's inhabitants as are paving, or sewerage, or water supply. Why, then, should not the people of the city have something to say as to when and where street railways should be provided?

If out of the public education which is being effected through the Amsterdam Ave. agitation, the idea should be spread abroad that New York and other cities need to change their whole system of treating street railway corporations, a great good would be effected, no matter how the fight may result over the particular issue which now absorbs public attention.

In our issue of Dec. 15, 1898, we noted the movement set on foot by the New York city officials to build two new bridges across the East River, to connect Manhattan Island and Brooklyn, and stated briefly our doubts of the present necessity for these new structures, and of the wisdom in any case of constructing them at the locations chosen. The surveys are now in progress for these bridges, and, if constructed, they will make the whole number of bridges spanning the East River four, three of which will be located within a length of the river of barely two miles. On March 16 the State Legislature, however, passed a bill authorizing the construction of a fifth bridge, to be located within a mile of the present Brooklyn Bridge, which increases the number of existing and projected bridge routes within the two miles of river front just mentioned to four, one of which is the existing Brooklyn Bridge, and another the New East River Bridge now under construction. This latest bridge scheme was opposed by the representatives from New York on purely party lines, but the bill authorizing its construction was, nevertheless, passed by a large majority. Otherwise than by this opposition no doubts have been raised, so far as we have heard, by either the state or the city lawmakers regarding the wisdom of building these three additional bridges, or of

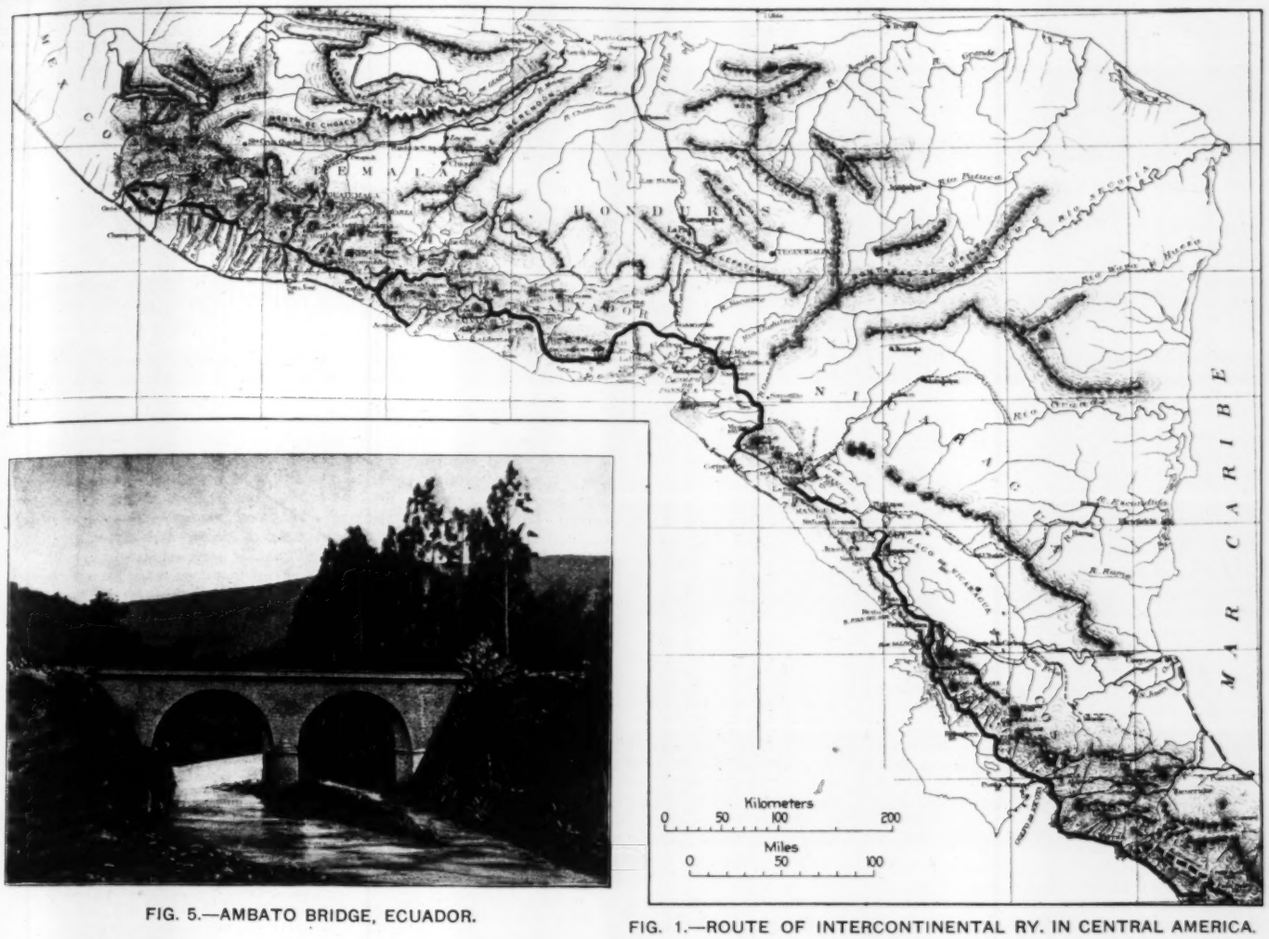

FIG. 1.—ROUTE OF INTERCONTINENTAL RY. IN CENTRAL AMERICA.

FIG. 5.—AMBATO BRIDGE, ECUADOR.

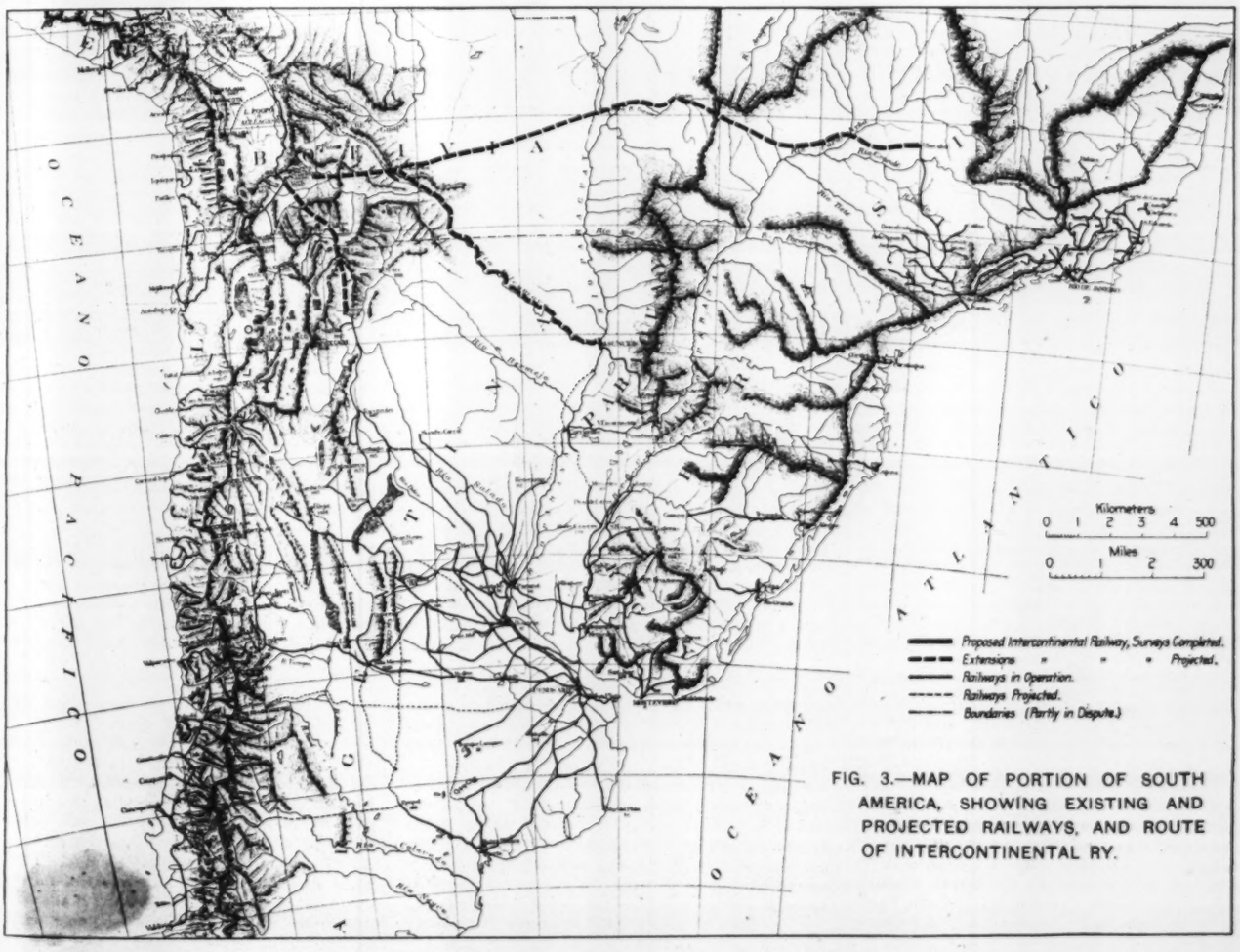

FIG. 3.—MAP OF PORTION OF SOUTH AMERICA, SHOWING EXISTING AND PROJECTED RAILWAYS, AND ROUTE OF INTERCONTINENTAL RY.

the ability of the city to secure the necessary money to pay for the work.

The absurdity of building more bridges across the East River at the locations proposed has already been shown in these columns, but the confidence with which it seems to be taken for granted that the city can afford to spend $20,000,000 apiece for their construction deserves some further mention in relation to the recent action of the same legislature, and of the New York city officials regarding the building of the New York Rapid Transit railway. The need of such a rapid transit line, and the feasibility of constructing it, are beyond question. There is little doubt, moreover, that if once built it would almost immediately prove a paying investment, so that even if the city should build it with its own money and lease it for operation, it would involve the city in no expense.

The present city authorities, however, have taken the ground that the city is at the end of its constitutional limit of credit, and hence cannot undertake the Rapid Transit Ry. as a public work; and the people are forced to accept this decision. Consequently, the new Rapid Transit bill now before the legislature proposes to turn over the franchise for the Rapid Transit road to a private corporation in perpetuity. How strange it is that the city has no money at all to invest in a system of railway communication which promises to pay enormous profits; and yet has millions galore to spend for bridges which are not needed, and which no one claims would make any direct return for the capital invested in them.

It appears to be pretty certain that the powers that be in New York city are determined that all the franchises for street railways shall be turned over to private corporations. The precedent of the city owning the underground line and leasing it for operation would be a dangerous one to establish. They are even ready to spend the city's money on unnecessary bridges if they may thereby insure that the city shall part forever with the right to use its streets for passenger railways. Verily, these be queer times in which we live!

Grim death is at last waking up Philadelphia to the character of its alleged water supply, as it has never been awakened before. A total of 3,931 cases and 404 deaths from typhoid fever between Jan. 1 and March 18, with 477 new cases and 44 deaths last week, has aroused organizations of every sort to demand that the water supply be purified. As necessary accompaniments of this measure, it is also urged that stringent measures be instituted to stop waste, and that numerous other improvements to the city's water-works be made at once. It was stated before the Manufacturers' Club on Monday, that from 50 to 75% of the present enormous waste is caused by some 20% of the consumers. There was also presented to the Club seven important instances where the operation of the works is seriously hampered, or threatened with stoppage, or else where the plant is liable to physical wreck, all because of the failure of councils to make appropriations for long-needed improvements. The high typhoid mortality of Philadelphia, its enormous waste of water and the gradual wreckage of its water-works plants, have been perfectly known among the engineers of the country for years past; and now the medical and daily press are giving the city a vast amount of free, but unwelcome, advertising. The city has persisted in placing quantity before quality, in connection with its water supply, until the cost of the annual waste, present and prospective, has become great enough to pay for filtering all the water the city can legitimately use. One branch of the City Council has appropriated $3,700,000 for improvements to the works, and to make a start towards filtration, but the other branch has been backing and filling for weeks. It may take warning from the present public agitation and finally pass the loan this week, but we should not be greatly surprised if, instead, advantage was taken of the demand for pure water to further some of the private filtration schemes so long and persistently urged. In the state of public feeling in Philadelphia this might be dangerous, for already it has been suggested that street demonstrations be made something like those in Chicago, which helped the city council there to drop the 50-year street railway franchise extensions so quickly. Of course, the Quaker city might be expected to act with more decorum than did the windy city when its wrath was aroused. The assemblage of a vast concourse of people in the large spaces about the city hall is the most impressive demonstration we have seen suggested for Philadelphia. Certainly with typhoid cases at the rate of 25,000, and deaths at the rate of 2,300 a year, which was the rate for last week, it would be surprising if the long-suffering Philadelphians did not rise and call those responsible to account.

The burning of the Windsor Hotel in New York city on the afternoon of March 17 furnishes the greatest object lesson in many years of the great danger to life which exists in every large building constructed in the common manner with wooden beams, studding and lathing and hollow spaces in every floor and partition through which fire can sweep without hindrance.

The story that the fire was started by a careless smoker throwing a lighted match against a lace curtain has been given wide publicity; but is absurd on its face, when the almost instantaneous spread of the fire after its first outbreak is taken into consideration.

This journal is in possession of information which indicates that the fire had been smouldering for hours before it finally broke out. While it was thus smouldering in a confined space, it would naturally generate a considerable amount of combustible gas, which spread through hollow partitions and floors from story to story and which was at once ignited when the flames finally burst out and allowed air to enter. The rapid spread of the flames over the doomed structure is thus fully explained; and it has in fact been paralleled in other fires in buildings of this type of construction where the combustion has begun in the concealed hollows of floors or walls and has gained headway before its discovery.

It cannot too often be explained to the public that the common type of building construction, such as is used in 99% of the buildings erected throughout the country, is as perfectly adapted to facilitate the destruction of the building by fire as if it had been designed with that end in view. It cannot be too often explained either that such dangerous construction is absolutely needless. It requires nothing more than the provision of inexpensive fire stops properly placed at the base of each partition and wall to divide these concealed hollow spaces, in which fire spreads so rapidly, into numerous separate compartments, from one to another of which the fire will only spread with difficulty. Had the fated Windsor Hotel been provided with such fire stops, which could have been put in place for no greater expense than was laid out on the lavish decoration of a single room, its occupants would have at least escaped with their lives, and probably the fire would have been discovered and extinguished with small loss.

We do not mean to imply by this that any form of wooden construction, no matter how defended, should be permitted in the construction of hotels, theatres, office buildings, apartment houses, etc., at the present day. Fireproof construction is now so inexpensive that there is no hardship in requiring its use in the construction of every new building designed for public use. The question that interests the public most, however, is whether other old-time hotels, theatres, etc., many of them known to be even worse firetraps than the Windsor, shall continue in business until their destruction is marked by another holocaust.

It seems to us that every such structure ought at least to be repaired by the placing of efficient fire stops. That much at least should be conceded to the demand of public safety. If in addition to this an impetus is given to the use of fireproof construction and to efficient means for checking the spread of flames in such buildings as are erected of wood, the sacrifice in the Windsor horror will not have been wholly in vain.

THE APPOINTMENT OF A COMMISSION TO INVESTIGATE ISTHMIAN CANAL ROUTES.

We said two weeks ago that the responsibility for further progress in the Nicaragua Canal matter now lies with President McKinley. Congress has authorized him

to make such full and complete investigation as to determine the most feasible and practicable route across said Isthmus for a canal, together with the cost of constructing same and placing the same under the control, management and ownership of the United States.

The President is given the fullest discretion; a fund of a million dollars is placed at his disposal; and he is instructed to provide for such a "full and complete investigation" as will satisfy the people of the United States, first, as to where the best ship canal route exists across the Central-American Isthmus; second, as to the cost of constructing a canal upon this best route; and third, as to the manner in which this nation may secure the control and ownership of such a waterway.

The selection of the men who are to advise this nation concerning its proposed embarkation in an enterprise involving the expenditure of from one hundred to two hundred millions of dollars, is a task of great responsibility. The private and corporate interests involved are enormous. They will inevitably bring a strong pressure to bear upon those who are to be appointed, and will try to influence them to favor the interests of this company or that syndicate, or to aid this or that concession-holder. It is essential at the very outset, then, that the men appointed to this work shall be men of such caliber that they can maintain an impartial and judicial attitude toward all these interests, and they will not be swayed by any influences which may be brought to bear. They must be men, moreover, whose high and honorable professional standing will give the public entire confidence in their opinion when it shall be rendered, and whose characters will be a guarantee that their investigations and conclusions have been made in the public interest, and the public interest alone, and "without fear or favor or hope of reward." If it is not entirely clear that this is true, suppose we take the reverse position—that men may be appointed who can be induced to favor the Panama company, or some set of Nicaragua concession-holders, or who, perhaps, have been already active partisans of one or another interest. Surely everyone must admit that an investigation and report by men of such reputation would be a most unsafe guide to the nation, and very far from what it desires and expects.

Bearing these things in mind, it is with feelings of the greatest astonishment that we received the news from Washington, sent out shortly after the adjournment of Congress, and before the President's departure upon his Southern trip, that he and his advisers had practically decided to reappoint the Walker Commission, with one or two additional members, to carry out the investigations provided for by Congress.

To say that such an appointment would fall far short of satisfying the just expectations of the American public, is to express it very mildly. The selection of the members of the Walker Commission in the first instance was one of the most unfortunate acts of the President's whole administration; but to repeat the appointment, under the present circumstances, would be a public disgrace.

We deem it our duty to speak with entire plainness, on behalf of the engineering profession, whose reputation is in no small degree at stake, and on behalf of the public as well, whose interests in this great enterprise it is the sworn duty of the Executive to defend.

Congress has ordered that an impartial investigation shall be made of all canal routes across the isthmus. Manifestly, then, the first essential is to secure impartial engineers to carry out the investigation; but Prof. L. M. Haupt, of the Walker Commission, is an avowed partisan of the Nicaragua route, and not only that, but an active and avowed partisan of the especial route across Nicaragua adopted by the Maritime Canal Co., of Nicaragua. Besides that, he has favored and publicly urged the acquirement by the Government of the particular Nicaragua concession granted to the Maritime Canal Co.

Proof of all these statements is furnished by Prof. Haupt's own published papers and addresses. We shall not take space to quote from them at length, but we will refer only to one of his most recent articles, in the "Manufacturer," headed "Summing Up 75 Years of Opposition to the Great Nicaragua Waterway." In this Prof. Haupt alleges that the Nicaragua project has always been opposed and delayed by the machinations of the Panama Canal Co. and the Pacific railroads, and continues in this strain:

> At this critical juncture, therefore, and in view of the alleged expiration of the existing concession, the effort on the part of the opponents manifests itself in every conceivable form looking to delays under pretense of safeguarding the interests of the people. * * * * * These and many similar statements are made in the interest of delay and with the evident purpose of preventing this country from ever securing control of this important highway of commerce.

Now, if Prof. Haupt chooses to think and to say that the distinguished members of Congress whose efforts have prevented this Government from paying several millions of money to the Maritime Canal Co. of Nicaragua for its concession, were merely working at the behest of the Pacific railroads and the Panama Canal Co.—if he holds this opinion, it is, of course, his privilege to hold it, and to advertise his holdings if he pleases. But it will be manifest to members of Congress, at least, that to hold and express such opinions should absolutely disqualify any person from serving as a member of a commission to investigate impartially the respective merits of the Panama and Nicaragua routes. What weight would such a man's opinion carry, who is known to have made up his mind beforehand?

But in the second place—and we must again be exceedingly frank—notwithstanding our long-continued pleasant personal relations with Prof. Haupt, we are obliged to say that, apart from his acknowledged partiality for the Maritime Canal Co.'s scheme, Prof. Haupt is such an avowed and acknowledged advocate of ship canals that his opinions on the Isthmian canal enterprise would carry no weight with the engineering profession. He has been an industrious promoter of the ship canal idea for many years. He has strongly urged the building of a ship canal from New York to Philadelphia, of one from Lake Erie to the Ohio River, and of a string of inland waterways from Philadelphia down the entire Atlantic coast. These are but samples; in fact, we have never heard of his discerning anything but glory and dollars in any waterway enterprise, no matter how chimerical and absurd it might be.

Now we do not question Prof. Haupt's honesty and sincerity in the crusade for waterway schemes which he has for years carried on; but we must contend again that such a crusader is not the one to choose to render an unbiased opinion upon the merits and demerits of a waterway enterprise. We do not select an advocate who has taken a strong ground upon one side of a particular case to sit upon the bench and try it.

Certainly no more than this should be necessary to show Prof. Haupt's entire unfitness for the appointment which the President has to make; but we are compelled to say in addition that with due recognition of Prof. Haupt's abilities, his professional record has by no means been such as to place him among the men at the head of the profession from whom selections should be made for so important and responsible a work.

Concerning Admiral Walker, the chairman of the present commission, we need say but little. We said at the time of his original appointment that he was conspicuously unfit to serve in such a capacity. He is not an engineer at all, but a retired naval officer. The absurdity of putting such a man at a task demanding the highest professional attainments of which an engineer is capable, is apparent on its face. What prestige would attach to Admiral Walker's opinion as to the practicability of the Ochoa dam? What capitalist would have confidence to embark in an engineering enterprise with the Admiral's estimate of the cost as a basis? Why should the nation be asked to invest its funds on the basis of such advice? It may be alleged that Admiral Walker was only placed upon the commission in an executive capacity; but such reports as have reached us concerning the inner history of the proceedings of the commission of which he is the head, have not been high testimonials to his executive ability.

Again, if Admiral Walker should be appointed upon the new commission, and should present a report favoring the Nicaragua route, or the particular plan of the Maritime Canal Co., would it command public confidence? There is already a strong impression abroad that the Admiral is strongly prejudiced in favor of the Nicaragua scheme. For example, the Washington correspondent of the "Mail and Express" said under date of March 10:

> It now looks as if the friends of the Nicaragua Canal route would win a victory in the White House. The President appears to be on their side. He has about decided to increase the present Nicaragua Canal Committee by adding to it one engineer from the army and one from civil life. If that is done the Panama route will receive but scant consideration. It is well known that the present committee, of which Admiral Walker is the head, is strongly in favor of the route selected by the Nicaragua Canal Co. It does not think much of the two other Nicaragua routes, but would recommend either of them rather than the new Panama Canal Co.'s route.
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> Admiral Walker and Senator Morgan had a conference with the President recently, and discussed the matter. The Senator and the Admiral, of course, think the Nicaragua route the best one.

The journal from which the above is quoted has long been one of the most conspicuous workers for the scheme to unload the Maritime Canal Co.'s concession upon the government. There is strong reason to believe that its sources of information on canal matters are peculiarly reliable. Moreover, the above newspaper statement is only a sample of many which have appeared in which Admiral Walker's prejudice in favor of the Nicaragua route has been made known. We are by no means disposed to place undue reliance upon floating press paragraphs; but it must be remembered that these all have their effect in molding public opinion, and enough has been made public concerning Admiral Walker to cast the gravest doubt upon his fitness to act as a disinterested adviser to the nation in this matter.

Concerning General P. C. Hains, the third member of the present commission, we have no criticisms to make. He has done his duty, so far as our information extends, to the best of his ability, and under circumstances of peculiar difficulty. It is noteworthy that in the preliminary report rendered by the commission on Dec. 29 (Eng. News, Jan. 5), Gen. Hains found it necessary to submit a minority report in which he estimated the cost of the canal at a figure 20% above the figure set by his colleagues.

Perhaps engineers of greater ability could be found in the Corps of Engineers than Gen. Hains. Be that as it may, he is certainly an engineer of large experience and enviable reputation, and one whose past record and known character give assurance of an honest and impartial discharge of all responsibilities entrusted to him.

If reports are not incorrect, it is to President McKinley's personal insistence that the country is indebted for Gen. Hains' presence upon the present Nicaragua Canal Commission. It is not without interest at this time to recall the circumstances under which the members of the Walker Commission were originally appointed. After Congress made provision for the commission in the Sundry Civil Bill of 1897, it is said that the President turned over the chief responsibility for the appointment of this commission to a certain member of his Cabinet. At that time the Nicaragua Canal Co. was in high hopes of securing the government guarantee of its bonds to the amount of $100,000,000. It was undoubtedly exceedingly anxious that those who should be placed upon that commission should be, to put it mildly, in harmony with its views. From our remarks above concerning the record of two members of the commission, since their appointment, the reader can draw his own conclusions as to the extent to which the influence of the canal company was effective in their selection.

The third member of the commission, as originally selected, was Capt. Oberlin M. Carter, a fact not without interest in view of developments since that time in connection with that officer. After Capt. Carter's resignation, when the charges against him on account of the Savannah harbor work were made public, the process of selecting an engineer to fill his place was conducted as follows, according to the "Army and Navy Journal":

> Secretary Alger telegraphed to Maj. S. S. Leach, C. E., and asked him if he would serve on the Commission. The correspondence with Maj. Leach, however, did not result in his acceptance of the appointment, and Maj. C. F. Powell, C. E., was tendered the appointment, and upon his acceptance he was directed to come to Washington to confer with the Secretary of War. Evidently Maj. Powell was objectionable to the canal advocates, for we understand they represented to the Administration that the country traversed by the canal route was extremely hilly, and that Maj. Powell would be physically unable to perform the work required of him, notwithstanding the fact that that officer had done a great deal of engineering work which necessitated considerable tramping. In any event, Maj. Powell was directed to return to his station, and then Maj. William T. Rossell was considered in connection with the place. Maj. Rossell was finally passed over, and the Department then ordered Maj. W. R. Livermore to duty as the representative of the Army on the Commission. The President signed his commission and Maj. Livermore was directed to report to Rear Admiral Walker in New York city.
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> In the meantime, the Administration awoke to the fact that a retired army officer was eligible to the appointment. Accordingly, Brig.-Gen. W. P. Craighill, retired, was asked by telegraph to accept the appointment on the Commission. Gen. Craighill coupled his acceptance with such conditions that the Department was forced to inform him that his services would not be needed. The Administration then proceeded to dispose of Maj. Livermore. On the ground that an officer of higher rank should be appointed to add dignity to the Commission, Maj. Livermore's appointment was revoked, and Col. Hains was ordered to fill the vacancy. It is to be hoped that Col. Hains will be satisfactory to the Administration—that is, the canal advocates, although we know full well that that officer will not allow anything or anybody to swerve him from his duty as he sees it.

It is also alleged that a considerable part of this curious proceeding was unknown to the President; and that when the state of affairs did become known to him, he ordered that the attempt to go through the Corps of Engineers to find a man to better fulfill certain unknown conditions should be dropped then and there, and that Gen. Hains should be appointed.

This is the story of the Walker Commission. Is there need to say more as to why its reappointment to the new task set by Congress would be a national disgrace? Is proof required that a report by it in favor of one canal route would be discredited in advance? Why, if we rightly understand the sentiment in Congress, one reason for the provision which it made for a new commission to investigate the whole subject de novo, was that it was felt that the report of the Walker Commission would not command public confidence.

We urged two weeks ago, and we repeat now, that the President's duty is to select, "from the engineering profession men of such great ability, broad experience and absolute impartiality and integrity, that the nation can safely be guided by their opinion, and the results of their investigation in undertaking the greatest engineering work of modern times." Nor will we confine the requirement to engineers, for there are other than engineering questions on which the public desires enlightenment. The legal status of the various companies and concessions should be investigated, either by the lawyers in the service of the Executive Departments at Washington, or, preferably, by a commission of lawyers of national reputation, whose names will compel the public acceptance of their conclusions.

Another matter which should be most fully and impartially investigated is that of the volume of commerce which can fairly be expected by either of the two proposed canals. Such an investigation was made in 1880 by the Bureau of Statistics of the Treasury Department, but is too far out of date now to be of much value. A new statistical investigation should be made under direction of some such acknowledged and non-partisan authority as Hon. Carroll D. Wright, or Prof. Henry C. Adams, both of them already in the Government service and of international reputation as competent statisticians. At present we have no authoritative basis whatever on which to compute the probable traffic returns of a trans-isthmian canal. Prof. Haupt has published certain estimates computed from figures collected in 1857. Some of us would like to have something a little nearer this end of the century!

We are aware that in some quarters a certain feeling of disappointment exists that Congress ordered further investigation of the canal question instead of at once appropriating funds for actual construction. But such disappointment is due to a misunderstanding of the real situation. Further extensive surveys and engineering work were necessary in Nicaragua in any case before contracts for actual construction could safely be let, and this work will require at least all the time that will elapse before the next session of Congress reopens. The President's investigating com-

mission, if it makes such accurate and reliable estimates of the relative cost of construction by the two routes as the public has a right to expect, will continue the work in Nicaragua, so that if that route should be recommended, and approved by Congress, the organization of construction work can be at once undertaken.

The additional fact that the United States has not yet secured a valid franchise for a Nicaragua canal, and that the means by which it may secure one at a reasonable figure are yet to be determined, has been so fully set forth in these columns that we need not discuss it again.

We believe that public sentiment is generally favorable to the construction by the government of a trans-isthmian canal, and that the Nicaragua route is in general preferred to that at Panama; but we believe it is also true that a very large proportion of the public demands more satisfactory and convincing testimony as to the relative merits of the two routes and as to their commercial value before it will favor the nation's undertaking either as a public enterprise.

It is the President's task to choose those who shall advise the nation. If he selects men whose opinions will command public confidence, there is every reason to believe that the next Congress will provide for the work of construction of the trans-isthmian waterway.

LETTERS TO THE EDITOR.

The "Pioneers' Society of Civil Engineers" Again.

Sir: I desire to offer an apology to "X.," who writes in your issue of March 16, and have regretted very much that I wrote as I did, for no one can have a keener realization of the fact that I have received far greater benefits from members of the profession than I can ever hope to make any return for.

Very respectfully,

March 17, 1899. H. T.

Prismoidal Formula.

Sir: Will Mr. "X," who makes it evident in his criticism of "H. T.," in your issue of March 16, that he can "deduce the prismoidal formula," do me the favor of giving the answer to this question:

"How many cubic yards are there in a rock cut 400 ft. in length, with vertical sides 27 ft. apart, the cuts at the regular 100 ft. stations being 5 ft., 33½ ft., 43 ft., 33 ft. and 3 ft.

Yours truly, "W."

New York, March 20, 1899.

A Concrete Chimney.

Sir: In reply to A. D. R.'s inquiry in this week's "News," I would say that the only concrete chimney of any size I know of is one at the works of the Pacific Coast Borax Co., Constable Hook, N. J., built in 1898. This chimney has a flue 7 ft. in diameter, and 150 ft. high; is built entirely of concrete, re-enforced by wrought-iron rings and wrought-iron vertical bars, in both the outer and inner shells. It was fully described in the "Engineering Record," Vol. 38, p. 189.

Yours respectfully,

W. W. Christie.

Paterson, N. J., March 17, 1899.

Concerning Special Legislation and the Corps of Engineers, U. S. A.

Sir: In justice to one of the most accomplished officers in the Ordnance Corps of our Army, I desire to correct the wrong impression conveyed in your editorial of the issue of March 9. I am not acquainted with Captain Williams, but Captain Rogers Birnie has since graduation at the head of his class at West Point been performing duty in a corps and of a kind which call for the exercise and possession of scientific and engineering qualities of a high order. Captain Birnie has occupied one of the most difficult posts in the Ordnance Department here connected with the design of high-powered guns and machinery during at least the ten years of my acquaintance with him. In view of the close touch which he has kept to mechanical engineering and construction, I have no doubt he will prove a valuable addition to the Engineer Corps in whatever grade he may be placed.

Very sincerely, H. M. Wilson.

Washington, D. C., March 13, 1899.

(We are pleased to learn that our surmise that "these favored men may be accomplished officers in their particular branch of the service," was correct in the case of Capt. Birnie, at least. But we must again repeat that the fact that Capt. Birnie has performed duties calling for "the exercise and possession of scientific and engineering qualities of a high order" in the design of high-powered guns does not necessarily make him an experienced civil engineer, competent to take the responsible command that the Act of Congress would give him. Experience and familiarity with specific duties are quite as essential to efficient service in this line as broad scientific attainments. What we particularly objected to, and what we still object to, aside from all questions of personal merit, is the injustice done to the Captains and the Majors who have long and faithfully served in the Engineer Corps, and who would each lose a step by reason of this special legislation. We can only regret that so excellent an officer as Capt. Birnie comes within its provisions.—Ed.)

Notes and Queries.

A correspondent has informed us that he believes the major share of the credit for the design of the settling and aerating basins at Fort Smith, Ark., described in our issue of Aug. 18, 1898, should be given to Mr. Jas. B. Gass, City Engineer of Fort Smith.

K. M. W., New York city, writes:

A square closed tank of large dimensions and of considerable weight has to resist an internal pressure of a certain number of pounds per sq. ft. How will this internal pressure affect the supporting beams of the tank? Or how will it distribute the dead load of the tank on its supports? I take it, that through the deflection of the bottom under the internal pressure, the weight of the tank is distributed over its supporting area with varying intensity. No interior braces or struts can be used.

Our correspondent is correct in thinking that the effect of the internal pressure will be to vary the pressure of the tank upon its supports. The internal pressure upon the roof of the tank will be carried down to the bottom by the sides and will tend to lift the outer circumference of the bottom off its supports. The actual distribution of the load of the tank will depend upon the stiffness of the bottom, the amount of pressure carried, the size and shape of the tank, and other considerations.

NOTES FROM THE ENGINEERING SCHOOLS.

University of Minnesota.—The "Bulletin" of Feb. 15 is devoted entirely to information concerning the College of Engineering and the Mechanic Arts, which is one of the principal departments of the University. In the department of mechanical engineering four elective courses in railway work are available as elective courses to seniors desiring to prepare themselves for special work in railway mechanical engineering; they are: Railway technology, railway design, locomotive construction, and locomotive road testing.

The location of the University is particularly favorable for students of railway engineering, being between the cities of St. Paul and Minneapolis, and in proximity to the shops, yards and headquarters of the extensive railway systems of the Northwest, with which the department is in closest touch. The Northwest Railway Club, meeting monthly for papers and discussions, is open for the attendance of students, while several are enrolled as members.

Special attention is given to work in machine design, eight hours per week each year being devoted to this subject, which runs through the entire four years of the course.

The Armour Institute, Chicago.—Mr. Philip D. Armour has added $750,000 to his previous gifts of $1,500,000 to the Institute. With this gift, a press dispatch states, the president, Rev. Frank Gunsaulus, proposes to make the Institute the "foremost school of technology in the world."

Workingmen's College, Melbourne, Australia.—We have received the "Prospectus" of this college for the year 1899, and find in it many things of interest. A year or more ago, in noticing the catalogue of the University of New South Wales, we had occasion to say that it appeared that the Australians were a little in advance of the rest of the world in their ideas of what a university should be, and that they were attempting to carry out in practice Ezra Cornell's ideal, that of a university where any person could find instruction in any subject. The Working Men's College of Melbourne seems to have the same ideal. The term "working men" means men who work, whether with brain or hand, at least it includes, from what we can gather from the "Prospectus," chemists, geologists mechanical, mining, electrical and metallurgical engineers, architects veterinary surgeons, book-keepers and stenographers. Courses are provided in the college for all of these classes of working men, as well as for wool-sorters, tailors, carpenters, coach-builders, carriage draftsmen, plumbers, gas fitters, telegraphers and musicians. It is proposed to reorganize classes in agriculture and rural industries. The college began in 1887 with 815 students. In 1891 it had 2,393, in 1893 only 1,055, and in 1898, 1,786. There has been a steady increase in the number since 1893. The cause of the great falling-off in 1893 is not stated, but it was probably due to the depression in business, which was especially severe in Australia in 1892. Of the 1,786 students in 1898, 486 were females, and 1,300 males. Of the latter 437 were over 21 years of age. The financial receipts were £5,939, of which about half was from government grants, and most of the remainder was students' fees.

A PROPOSED STANDARD METHOD FOR THE GRADING OF FOUNDRY PIG-IRON.

The question of the grading of pig-iron has been a vexed one for many years, but the old method of grading by the appearance of the fracture is still used for foundry irons. At a recent meeting of the Pittsburg Foundrymen's Association, a paper on the subject of "Yard Grading of Pig-Iron," was read by Dr. Wm. B. Phillips, in which he showed that the three grades of pig-iron known 200 years ago, viz.: gray, mottled and white, had now grown into 13 regular grades "and as many more as may be necessary to confuse the purchaser." He suggests that the number of grades be reduced to six, and that the grading be done by analysis, the three elements—silicon, combined carbon and sulphur—being used, with the understanding that phosphorus may be included for certain purposes. The constitution of the six grades which he proposes are as follows:

	Silicon, %.	Combined carbon, %.	Sulphur, %.
Silvery irons	5 to 6	0.10 to 0.30	0.01 to 0.04
Soft irons	3 to 5	0.20 to 0.60	0.01 to 0.05
Foundry irons	2 to 3	0.30 to 0.90	0.01 to 0.07
Gray forge	1 to 2	0.40 to 1.25	0.04 to 0.09
Mottled .....0.6 to 1		0.50 to 1.80	0.06 to 0.11
White .....0.1 to 0.6		1. to 2.50	0.08 to 0.30

After the discussion of Dr. Phillips's paper a resolution was passed recommending to the American Foundrymen's Association the adoption of standard methods of grading pig-iron for foundry purposes, and requesting the Pittsburg Association's representative to bring the matter before the executive committee for action.

THE ACTUAL AREA OF GREATER NEW YORK is figured up as follows by the Board of Improvements: Manhattan Borough, or Manhattan Island, 13,487 acres; Borough of the Bronx, or annexed district, 26,270 acres; Borough of Richmond, or Staten Island, 36,001 acres; Borough of Brooklyn, 42,095 acres; Borough of Queens, 79,347 acres. The official total area of Greater New York is 306 sq. miles, with an estimated population of 3,200,000.

THE STEEL PIPE LINE for the Indianapolis waterworks is made of ¼-in. plates in courses 6 ft. long, there being two plates to each course. A peculiar feature of the construction is that angle-iron stiffening rings are riveted outside the pipe at intervals of 10 ft. The pipe line takes the place of an old wooden flume from the upper canal, and furnishes power to the water-works pumping station and to several mills, the turbines at the pumping station being under a head of 50 ft. The plates were rolled punched and dipped at the works of the Springfield Boiler & Mfg. Co., of Springfield, Ill.

FREIGHT LOCOMOTIVES with large driving wheels are to be used on the Lehigh Valley R. R., running between Buffalo and Sayre. They were designed by Mr. Samuel Higgins, Superintendent of Motive Power, and two will be built by the Baldwin Locomotive Works, of Philadelphia, Pa. After these have been tried in service about 20 more will be built, with such modifications as may seem desirable. One engine will be single, with cylinders 21 × 30 ins. The other will be a Vauclain four-cylinder compound, with cylinders 17 × 30 and 28 × 30 ins. In other respects they will be alike; driving wheels, 5 ft. 2 ins. diameter; truck wheels, 3 ft.; driving wheelbase, 16 ft. 3 ins.; total wheelbase, 25 ft. 5 ins.; weight in working order, 175,000 lbs., with 155,000 lbs. on the driving wheels. The two forward axles will have the springs over the boxes, while the two rear axles will have yokes on the boxes, carrying three inverted springs between the axles and the end of the frame. The engines are intended to haul train loads of 2,000 tons, and to do away with double-header trains. A heavy compound consolidation pusher engine of this road was illustrated in our issue of Nov. 24, 1898.

PERMANENT WAY FOR STEAM RAILWAYS.

The publication in our issue of Jan. 5 last of Mr. J. W. Schaub's paper proposing a concrete foundation for the rails of steam railways in place of the present wooden ties and ballast, and our editorial discussion of the same subject, brought to us a number of interesting letters in which various features of the proposed designs were criticised, and the merits of other plans for improvements in permanent way were set forth. We have delayed the publication of these letters for some time, desiring to accompany them with some further editorial discussion of the subject, which pressure of other matters has hitherto prevented our preparing. We now present these letters as follows:

Sir: Noting in your issue of Jan. 5, the article by J. W. Schaub, M. Am. Soc. C. E., on "Permanent Track," and your editorial on the same subject, I send you a plan of my proposed metallic stringer, covered by U. S. Patent

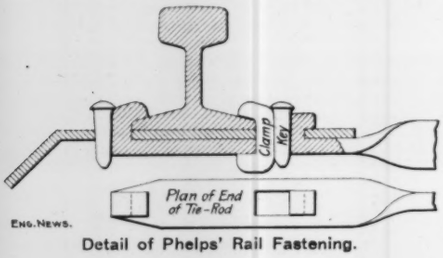
Half Cross-Section of Railway Track Laid with Phelps' Metallic Longitudinals.

No. 598,957, which will doubtless interest you while on that subject. If we do return to the longitudinal system of supporting track, this device has great advantages over concrete, and its cost being hardly in excess of cross-ties and tie-plates, does not prohibit its use. I should be pleased to have you criticise it.

Yours truly, C. S. Phelps.

South Carolina & Georgia R. R., Charleston, S. C., Jan. 12, 1899.

Sir: I was much interested in your articles on a permanent way for railroads; but it seems to me that the resting of the concrete stringers on a 2-in. layer of sand is a trifle faulty. In street work, blocks laid on sand settle more or less, and the sand in this case is confined at the sides by the curb. Could not a trench filled with puddled clay under the stringers be substituted for the layer of sand; or, could not a trench, say 1 ft. deep, filled 10 ins. with puddled clay and 2 ins. with sand, be used—the sand in this case being confined by the sides of the cut? Further, is not an inch layer of asphalt rather an "expensive roofing?" It is well known that asphalt on an untraveled street, soon disintegrates, that a moderate traffic is a positive benefit to it. Again, there is bound to be some jarring of the rail due to the passing loads that



Detail of Phelps' Rail Fastening.

will be communicated to the asphalt which can ill endure it, having but a dirt base. The cracking of an asphalt pavement next the rails of the best constructed street railway often occurs, yet this asphalt has a 6-in. concrete base and 1½ ins. of binder to steady it. The writer has seen grass growing in an asphalt street where there was no travel. Where this occurs there the roof ceases to be waterproof.

It seems to me that the use of crude oil, sprinkled between the rails and on the slopes, say two or three times a year, might give a dustless, waterproof covering at a comparatively slight cost.

Your design is certainly a move in the right direction; but is it your opinion that the gage-bar gives enough bond between the two lines of stringers? These two lines should work as one as far as possible. Would they do so in your construction? T. C. B.

Washington, D. C., Jan. 9, 1899.

Sir: Your editorial in the issue of Jan. 5, 1899, on "Permanent Way for Railroads," sums up the defects of the present system of railway track construction in such a convincing way, as to greatly strengthen the impression with engineers, that the time is not far distant when the present makeshift track must give way, on the principal railways at least, to a more rational system.

Having had occasion to give much thought and study to the matter during the last four years, I have come to the same conclusion as yourself in favor of a longitudinal system of support for the rails. But, in my plans, the contact of rail is not continuous, and the longitudinal support is of steel instead of concrete. At the proper time I intend to publish the plans. I may say, however, that the total cost does not differ much from the cost of your system.

At this time I wish to call attention to only one feature, which it seems would have an important bearing on the durability of such track, namely, it is impossible to prevent dust and sand from getting under the rail base. The experience, on the whole very favorable, with the longitudinal system of iron trough supports under the rails, known as the Hilfs system, 32 years ago, in Germany, showed that there was considerable abrasion between rail and trough.

In your system the base of the rail would be protected on one side by the coating of asphalt, as long as it would not crumble; but from the other, or outside, the sand would be able to get in, or rather, would be sucked under the rail, where it would have the effect of gradually grinding out a longitudinal depression on the concrete block. The abrasion on the concrete would probably not be even. It would be greater between the gage bars and holding-down bolts and less near them. An unevenness, however small, having once begun, would soon increase, and as a result the rails would after a while be no longer continuously supported at the base; they would probably be supported only at the gage bars, where the wear would be less on account of the bolt connections, which would keep the rail from bending up and down. I doubt, too, whether the proposed dowel-pin connection between concrete blocks would be sufficient to transmit without motion the very considerable shearing strains under wheel loads in such a way as not to disclose a weak point there similar to that of a rail joint. A stiff rail having great virtue with the present track system would be not less valuable with the longitudinal supports; for the rail is somewhat of the nature of an anvil, receiving blows from badly balanced driving wheels and flat car wheels; both of them of daily occurrence, and more destructive to track than the heaviest concentrated but smoothly rolling wheel loads. Experiment with the different systems for at least a year would be very instructive. Gustav Lindenthal.

New York, Jan. 10, 1899.

Sir: I have read with interest Mr. Schaub's article and your editorial on the subject of substituting concrete flooring or beams for ballast and wooden ties, and, while the ideas are certainly good, there are some points open to criticism.

In the first place, your own suggested design is open to the objection that there is a risk of water getting into the earth filling between the beams, causing it to heave in case of freezing, which would burst the asphalt covering. The asphalt will not make or maintain a water-tight joint with the steel or concrete, and under rain or melting snow there would probably be considerable leakage of water into the filling. The crowning of the asphalt seems to be unnecessarily high.

The 1-in. coat of asphalt is very liable to be broken or cracked by derailed wheels, broken brakebeams, etc., and this is a contingency that must not be neglected. Even on the best track evidences may be found of damage done in this way. Your own design is perhaps less open to objection in this respect, as such damage would not necessarily injure the track supports. In Mr. Schaub's plan, however, derailed wheels would be likely to crack the concrete platforms, which would then be gradually disintegrated by frost and weather.

I agree with your remarks as to the rigidity of railway track, and have several times expressed the opinion that if the old rails had been immovably fastened to their stone supports, or to the leveled bed-rock in Stephenson's noted experiment, the results would have been at least fairly satisfactory. Under the conditions of construction of those early days, however, the fastenings would inevitably soon become loose, allowing the rail to be pounded and battered between the wheel and the stone. The smoothness of riding on good track laid with high 100-lb. rails, as compared with shallower and lighter rails, is an evidence that rigidity is not necessarily an evil.

A certain element of stiffness in the rail itself is essential, or its tendency to deflect and take a wave-motion will impose severe strains upon the fastenings, and I doubt whether it would be advisable to use 70-lb. rails, even on concrete, for traffic which now requires 100-lb. rails. This is specially doubtful with fastenings 40 ins. apart. It may be well to point out that one of the most important requirements for the concrete track is that of securing thoroughly efficient fastenings which will hold the rails immovably upon the concrete, as any play between them will make a hard-riding road and introduce very destructive influences. In this respect, Mr. Schaub's design appears to be defective, while the use of 1-in. through tie-rods at intervals of 18 ins. involves an excessive use of iron which might be applied to better advantage.

The bearing surface of the rail upon the concrete should be as even and unbroken as possible, and it is a question whether Mr. Schaub's continuous concrete bearing is not better than your design, with its grooves for the gage bars at intervals of 40 ins. You also refer to the use of rail joints giving a base support, but this would necessitate a special construction of the concrete blocks at fixed points, which might not always be convenient in rail renewals. Such a construction would also break up the continuity of the bearing, and I should propose the use of angle bars, with specially secure anchorage attachments for the rail ends and the flanges of the angle bars. The plan of securing the joints by screws through these flanges is practiced to some extent in this country and abroad.

Probably the most permanent and effective track construction would be to embed the rail base in the concrete beam, but there are many practical objections to such a plan. It might, however, be practicable to shape one edge of this beam so as to afford a groove for the reception of the rail base, thus forming a continuous fastening.

As to the effect of frost on track laid with steel ties, which question is referred to in your editorial, I should suppose that the winters of Germany and Switzerland would be severe enough to test such a construction, and steel ties are used very extensively in both those countries.

The heavy wheel loads and heavy traffic of busy lines impose such destructive effect upon the track that the labor and expense of maintenance are growing almost beyond reasonable limits. As the heavy locomotives and the large-capacity cars have been introduced in order to effect material economies in the cost of transportation, they may in turn lead to the introduction of a permanent concrete substructure for the rails, in order to effect a similar economy in the cost of maintenance.

Yours very truly, Track.

Chicago, Jan. 10, 1899.

Sir: Since the question of permanent way for standard railway practice has been broached by Engineering News, and knowing that the subject is one apt to provoke considerable discussion, I take the liberty of suggesting some ideas, which seem to me to be pertinent. To begin with, the purely engineering reasons for adopting such a system of track construction are so well stated in the two articles in your issue of Jan. 5, that a repetition here is unnecessary. That we are moving towards such construction is also true, if we restrict the statement to railways operating in the thickly populated sections of the country, or where the volume and conditions of passenger and freight traffic will warrant the expenditure of large sums on track construction. That is to say, such a permanent way could exist between New York and Buffalo, New York and Philadelphia, or between New York and Boston, while it would not do between small cities in sparsely settled localities. In fact no better example of what we may look forward to can be found than the one afforded by our street railway systems. New York and other large cities can afford to construct the heaviest form of roadbed with heavy rails, cast-iron yokes, concrete foundations, etc. Smaller places must content themselves with lighter and cheaper construction. The same applies with equal force to trunk line steam railways.

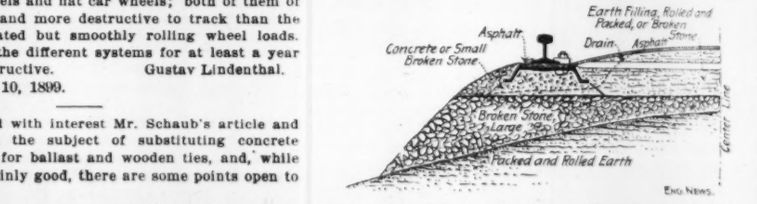


Fig. 1.—Half Cross-Section of Metallic Longitudinal Track System with Asphalt Covering.

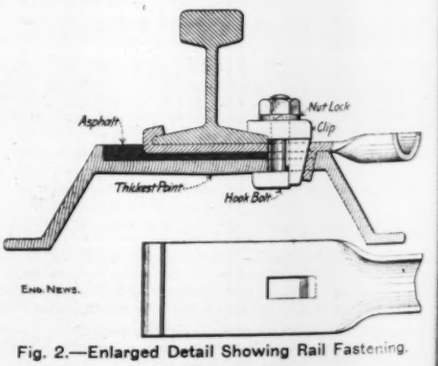


Fig. 2.—Enlarged Detail Showing Rail Fastening.

From the engineer's standpoint, the adoption of such a system cannot come about any too soon. On the other hand the commercial aspect, which is after all the controlling one, must be considered. The commercial arguments for or against a permanent way such as you describe can be summed up in the question, Will it pay? In other words, after subtracting the total operating expense from the total income will the remain-

der be sufficient to compensate the stockholders and other interested parties? This is the practical way of looking at it, and the one upon which the adoption of such a system will hinge. Considering, therefore, these items separately, for any set rate per ton-mile, the income depends primarily upon distance, amount hauled and speed. All three of these factors depend directly upon the roadbed. Operating expenses, such as maintenance of way, damages and claims, losses due to delays, wear and tear on rolling stock, and the number of em-

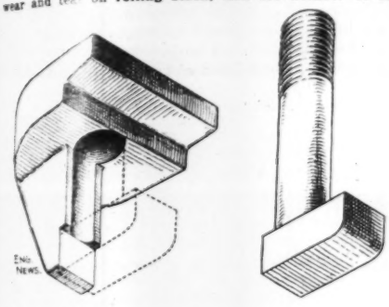


Fig. 3.—Detail of Rail Clip and Bolt.

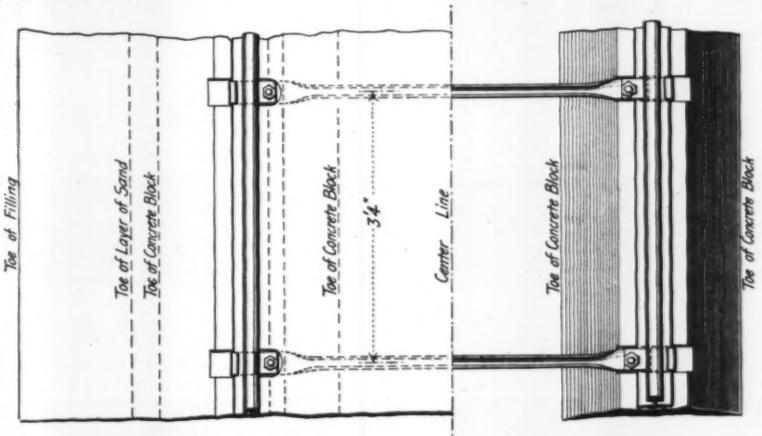
ployees, would be considerably reduced. Thus leaving increased interest on the greater investment as the only income-reducing factor.

From the engineering standpoint, there are a number of questions that can only be answered by experience under actual working conditions, but it is quite certain that consequent heaving of the track. To my mind these constructions represent an ultimate form, but I am inclined to believe that the third type, just mentioned, will first come into use. It can be constructed at a less cost than the others, and is a transition form less radical than either of the others, and past experience has shown that changes in railway methods or designs have necessarily been gradual.

The accompanying sketch, Fig. 1, represents a half cross-section of this "transition form," to construct which the earth roadbed would be graded off with a decided crown, and packed by heavy steam rollers. Upon this would be distributed and leveled off, broken stone to a depth not exceeding 6 ins. at the center. Two piles of smaller broken stone would then be distributed along gage distance apart. The steel channels would be dropped over these piles of broken stone and tamped to approximate level. The rails would then be laid, the gage bars placed, and the track lined and leveled. A suggestion for the channel and the method of locking the gage bars, rails and channels together, is shown in Fig. 2. The long web of the channel is thickened up to prevent bending under the weight of trains.

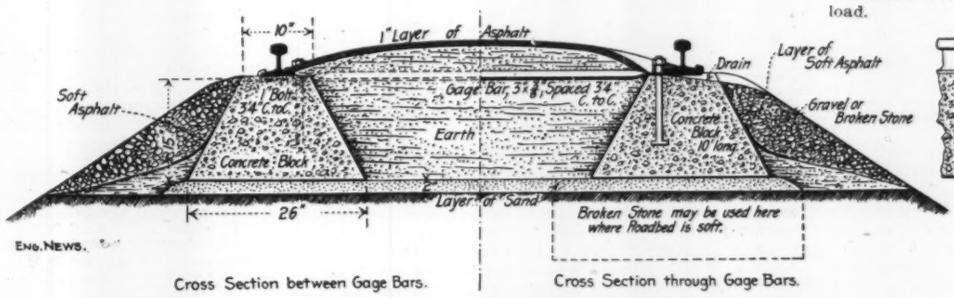
The channel has oblong holes, about 1 × 1½ ins., punched every 3 ft., through which the hook bolt and clamp block pass. The sloping sides of the channel are continued up a short distance (about ¾ in.) forming a trough, which is filled with soft asphalt to form a cushion, prevent wear of rails and channels, and incidentally reduce the noise.

The gage bars are similar to those described in your article, except that a rectangular hole is punched instead of a round one, and the tongue is bent down, as shown, to form a backing for the clip. This clip is cast iron, made as shown in Fig. 3, with the wedge face perpendicular to the clip face so that the contact between clip and rail is of considerable area. The space between the



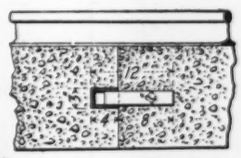
Half Plan, Asphalt Cover in Place.

Half Plan before Filling between Blocks and Asphalt Cover are Laid.



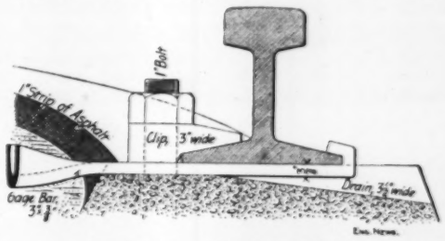
Cross Section between Gage Bars.

Cross Section through Gage Bars.



Longitudinal Section between Abutting Ends of Concrete Blocks.

It will be seen from the above letters that several of our correspondents are inclined to favor the steel longitudinal system of construction, rather than the concrete longitudinals. But in Europe steel longitudinals have been used to a large extent; in Germany several hundred miles of railway have been laid with them, and the ex-



Detail of Gage-Bar and Rail-Clip.

perience in their use extends over many years. The net result appears to be that the longitudinals are finally discarded in favor of metal ties. The defects of the longitudinal system appear to be the difficulty in evenly tamping the ballast under the longitudinal to keep it in good surface, the fact that the ballast beneath the longitudinal becomes at times so closely packed as to interfere with drainage through it, the difficulty of making renewals on curves, since each piece must be bent hot at the shops to fit the particular curve, and in general the fact that steel longitudinals were found by experience to be on the whole more expensive than steel cross ties.

It seems to us, however, that the chief argument against the use of either metal cross ties or longitudinals are that they make the ballast and its manipulation by far too important. It is the ballast, after all, in either of these systems that transmits the load on the rail to the supporting earth, and to all intents and purposes the steel tie or longitudinal is merely a thin plate to distribute the load upon the ballast, and to hold it in place. Now we believe that to make an ideal permanent way we must get away from the use of ballast, and from the necessity of continually spending money to dig it up and tamp it down and spread it here and smooth it there.

Suppose we liken the railway track to a building. The problem is, what sort of a foundation shall we put under it. If it is a very cheap sort of building, we can support it on "mud-sills." Simply lay sticks of timber on the ground for it to rest upon. This foundation costs very little to put in place; but it will require frequent repair, replacement and adjustment if the building is not to settle unequally when the soil beneath it freezes and thaws, or becomes soaked with rain, and when the wooden sills rot or crush under their load.

DESIGN FOR A PERMANENT WAY FOR STEAM RAILWAYS.

(Reprinted from Engineering News of Jan. 5, 1899.)

in any form of permanent way the present tie construction will be abandoned. Breaking away from past and present customs, three types suggest themselves: A platform type—that is, one in which the ordinary crowned earth bed is capped by a continuous foundation of concrete upon which rests the rails. This form has been suggested by Mr. Schaub in Engineering News; the second form, one using concrete beams or blocks and suitable spaces or gage bars, as suggested in your editorial. The third form, employing steel channel stringers, and similar gage bars or spacers. The first two possess a very decided advantage in that they carry the track foundation to a considerable depth below the surface, thus eliminating the possibility of soft ground due to frost and channels and track can be filled in with broken stone, gravel or earth, and covered with asphalt or not. If covered suitable drain pockets would have to be placed at regular intervals.

No attempt has been made to figure out the cost of construction of this girder construction for two reasons: First, it is evident that the form here suggested could be constructed within the limits set, in the discussion in Engineering News of Jan. 6; second, the prices for materials and labor are apt to change enough before extensive work is done along these lines to destroy the accuracy of estimates made at the present time.

"Interested."

New York city, Jan. 15, 1899.

If we want to make a little better foundation for the building, we can lay the mud-sills in a bed of broken stone, and this is practically what our best railways are doing to-day. No one would claim that such a foundation could be called permanent for a building; and we have already shown how far it falls short of being permanent for a railway track.

The next step in advance would be to take out the mud sills, fill the cavity left with broken stone, and put a steel plate on top to distribute the weight. This is practically what the steel tie

or steel longitudinal proposition amounts to. Now, if any engineer were to see a building supported in such a fashion he would inquire why the man who came so near making a solid masonry foundation didn't complete the job. All it wants is enough cement and sand to fill up the chinks between the pieces of broken stone to make a good concrete foundation; and the steel plate, which will then be no longer needed, will more than pay for the cement and sand.

Referring to the cross-sections of steel longitudinal track systems shown above, it will be seen that when the systems are put in place as their authors design, there will be a nice little prism of packed broken stone supporting the steel plate on which the rail is to rest. Now when, with a good deal of labor this broken stone is packed into just the right shape, why not put something into it that will keep it there, instead of having it jarred out of place by traffic or heaved to pieces by frost in a short time?

It appears to us that the sole advantage that can be claimed for the broken stone system over the concrete is that the water can drain off through the broken stone. Rather let us say it is supposed to; for it may as well be confessed that our methods of protection of the roadbed from water at present in use are exceedingly crude.

In theory, the earth roadbed of a railway is supposed to be smoothed off at subgrade with a decided crown, and the water is supposed to percolate down through the porous ballast and then run off the earth surface. In practice, after the roadbed is graded, the ties and rails are laid and the ballast is dumped down without regard to the form or surface of the subgrade. The result is that the water soaks down through the ballast and saturates the roadbed more or less according to its porosity. Every engineer in charge of maintenance of way knows of cuts where in very wet seasons the whole roadbed becomes saturated and soft. We call attention to these points merely to make it clear that any system of really excluding water from the surface of the subgrade would be a great advance over the present practice on even the best roads.

Let us next take up some of the objections which are raised above to the proposed concrete longitudinal system. In order that these may be clearly understood, we reprint here the cuts illustrating it from our issue of Jan. 5. The objections offered are as follows:

1. It is alleged that the rail might wear its way into the concrete base.

It is a well-known fact that rails in the present track do wear into ties, tie-plates, spikes, etc., and it is reasonable to ask whether similar wear may not occur in the manner suggested by Mr. Lindenthal above. Let us see what causes this wear. We believe that most competent observers agree that it is due to the motion of the rail under the passage of trains. This wear is found to be greatest, we believe, where light rails are used under heavy rolling stock, and it goes on more rapidly when the track has been down long enough for the spikes to loosen their hold. Stand beside a railway line when a train is passing and watch the motion of the rail as wheel after wheel passes over it. It will be seen that the rail is continually rising and falling, carrying the ties with it to a greater or less extent, and producing an amount of motion which it is by no means strange should cause wear. With very stiff rails, and ties placed close together, the motion is considerably reduced, but a considerable motion must inevitably take place so long as the rail is supported on compressible wooden ties.

To see that the above is the true explanation of the cause of the wear of ties, tie-plates and spikes, we have only to turn to street railway practice. Here much deeper and stiffer rails are used, and they are held down to their supports by the paving. The result is that on a well-laid street railway track there is hardly a perceptible motion of the rail as the car passes over it, and wear of the rail upon its supports does not take place.

Turning now to the proposed concrete construction for steam railways, it seems clear that if the concrete is given a sufficient base to carry the load, and the rail is held down firmly to the concrete in the manner proposed, there need be no reason to expect wear between them.

2. Would the proposed asphalt covering between the rails be durable and waterproof?

Our answer to this question would be: Probably not, if it were laid of the same composition as paving asphalt. What we had in mind was some asphalt composition which should be made with a view to waterproofness, instead of solidity under traffic. Perhaps no such composition could be made which would be at once waterproof, durable, and not too costly. In that case some other waterproof covering might be devised. Perhaps a mixture of tar and gravel such as is used for roofing could be laid which would be inexpensive and fairly durable. Perhaps a single course of bricks laid flat, with the cracks between them filled with pitch, as in street paving, might prove satisfactory. In the design submitted in our issue of Jan. 5, one novelty was the proposition to protect by a waterproof covering the space between the rails; but we are not wedded to any particular style or kind of covering by any means.

Again, the proposition to roof over the space between the rails is not essential to the use of the proposed concrete longitudinals. It is quite possible that sufficiently good drainage could be furnished by laying cross drain-tile of small diameter underneath the concrete, with suitable porous ballast to lead the water to the sides. In fact there are some porous gravelly soils where even this precaution might be unnecessary. On the other hand, there are also heavy clay soils where the most thorough drainage, to keep the water from softening the earth at the base of the concrete, would be absolutely essential. Like any other foundation problem, the treatment would need to be varied to suit the local conditions.

3. Connection between Adjacent Concrete Blocks.—Stiff Rails.—Rail Joints.

Mr. Lindenthal's criticism that the dowel connection shown was not strong enough is probably well founded. We would change this by molding a cast-iron socket of, say, 4 ins. internal diameter, into the abutting faces of both concrete blocks. A short loose connecting piece would then be slipped in when the blocks were laid. We may also remark that a stiff rail would be valuable, as Mr. Lindenthal and "Track" suggest, to distribute the wheel load over the concrete. The suggestion that angle-bar joints would avoid the difficulties that might be met in the use of a base-supported joint with the concrete construction, is also a good one.

One other correspondent, whose letter was so brief that we did not reprint it with those above, says:

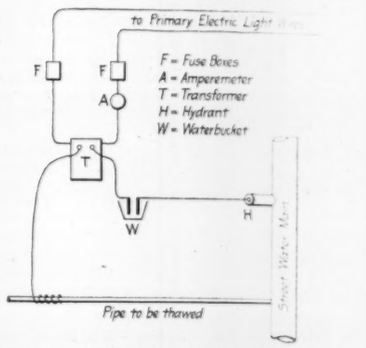
> I fully believe that this matter of a permanent track for railways will be developed on lines similar to that which you have laid out in your design. If I would be permitted to make a suggestion, I might say that I think your concrete blocks are too small. To my mind, there is always a certain amount of inertia or rigidity necessary in the support for a rail in order to overcome excessive vibration.

We are aware that the concrete base looks rather small in our proposed design; but computations show that it would weigh over 600 lbs. per lin. ft. of track. The present cross-tie construction, if we take 16 ties to a rail length, each weighing 160 lbs., weighs only 85 lbs. per lin. ft. of track. We agree with our correspondent that a certain amount of weight and inertia in the body to which the rails are fastened is a desideratum for a rigid and durable track; and if the suggested concrete system is not heavy enough it could be easily made heavier. It will be seen, however, that even with the present dimensions, the concrete would have much greater mass and inertia to absorb the shocks upon the rail than either the wooden tie or steel tie systems possess.

In conclusion, we thank our several correspondents for the interest which they have displayed, and their contributions to the discussion, which has certainly made more clear what are the possibilities, at least, in the direction of improved permanent way for steam railways.

THAWING FROZEN WATER PIPES BY ELECTRICITY

The severe weather of the past winter has caused an unusually large number of frozen water pipes in the northwest. A combination of extreme cold and but little snow led to deep freezing of the ground. Some 50 cities and villages in the northwest, we are informed, have thawed frozen pipes by means of an electric current. Most of the pipes, it appears, were services, but some were for fire mains. The method employed was developed at the University of Wisconsin, which has, in what may be termed the new spirit of our best Universities, taken great pains to give the people the benefit of the device. We understand that the method has been put in working shape by Professors Dugald Jackson and R. W. Wood, of the University. The University, through a circular signed by Mr. C. K. Adams, President, volunteered not only full information regarding the process, but offered to send competent men from the institution to aid in putting the device in operation, charging only the actual expenses incurred. The circular advises the co-operation of water-works officials and electric lighting companies. It states that the cost of thawing services in Madison has been, ordinarily, from $5 to $10. It is estimated that 75 HP. would be required to thaw out 100 ft. of frozen 6-in. main in 30 minutes.



Sketch Showing Method of Using Alternating Current for Thawing Frozen Water Pipes.

Another circular issued by the University is as follows:

For Service Pipes up to 1½ Ins. in Diameter.—The current which is required for thawing service pipes satisfactorily is from 200 to 300 amperes. The source of current should have a pressure of not less than 50 volts. Where electric light lines carrying alternate currents are available, a transformer or transformers in parallel may be used as a source of current. It is very important that direct connection of pipes to house lines be avoided on account of danger of fire in which the house is placed by such connection. Where alternating currents are not available, continuous current feeder lines may be used, but these should be entirely separated from the distributing network of conductors.

The accompanying sketch will show the way in which the appliances should be connected when an alternating current is used with transformer. The secondary leads from the transformer should be quite large, such as No. 3 B. & S. gage, or larger. In making connection to the pipes, one of the secondary leads should be taken into the house to which the frozen service pipe leads and contact made at that point by some form of metallic clamp or by simply giving the conductor two or three tight twists about the pipe at any point where the pipe is exposed or at a faucet in the house. The other secondary lead should be put in contact with the water system outside of the house, and in a similar manner. This contact may be made at a hydrant, or at an adjoining service box, or pipes in a neighboring house. When there are two houses near together, each with frozen service pipes, the two secondary leads may be connected to the pipes within these houses and both frozen service pipes thawed out at once.

While the thawing process is going on, the faucet should be open in the house to which the service pipe leads. In one of the secondary leads should be inserted a water resistance which consists (for convenience) of a bucket of water containing a bowlful of salt, and two sheet-iron or copper plates to which the ends of the severed lead are attached. This serves to control the current. In the primary leads from the electric light line to the transformer it is highly desirable to have a fuse in each lead, and an ampere meter. When all connections are made, the plates are placed in the bucket and are then moved towards each other until the ampere meter records a proper current. If the primary pressure is 1,000 volts and the secondary pressure 50 volts, the current should ordinarily approach 15 amperes. If the primary pressure is 2,000 volts and the secondary pressure 50 volts, the ampere meter reading should ordinarily approach 7.5 amperes.

Water ordinarily begins to flow in a time not much less than ten minutes or not greater than one hour. If the secondary current is quite close to 300 amperes the period seldom exceeds one-half hour. The frozen pipes are often

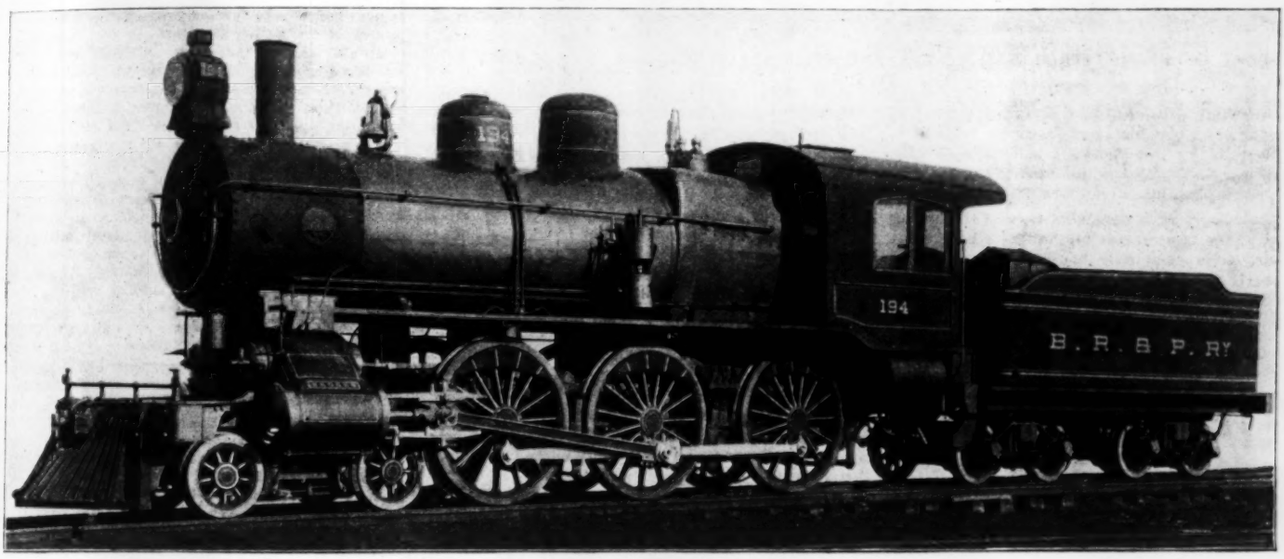
split by the action of the frozen water, and these at once begin to leak when the ice is thawed away. For this reason it is desirable to have a plumber where he may be readily called to care for the leaky pipe.

The electric current, when properly used, will not damage the pipes. It is desirable to watch brass and iron connections to lead or iron service pipes, as they sometimes heat on account of poor contact. If such heating appears to be excessive, the current may be reduced with a resulting increase in the duration of time for thawing.

After the pipe has been thawed it is desirable to let the water run continuously for a considerable time, inasmuch as the ground all around the pipe is frozen and the pipe is liable to freeze up again unless the water circulates.

For Larger Service Pipes and Mains.—The amount of power involved and the difficulties to be overcome in thawing large pipes make it desirable that special information regarding their size, material and location be furnished before instructions are sent out. It is very desirable that the thawing of such pipes be carried on under the immediate direction of some one from the University who has had experience in the work. The plan will serve excellently to thaw frozen hydrants and hydrant leads, of which there is complaint from a large number of towns.

The first of the two circulars states that in sending calls for assistance, or information, care



TEN-WHEEL PASSENGER LOCOMOTIVE; BUFFALO, ROCHESTER & PITTSBURG R. R.
Brooks Locomotive Works, Builders.

should be taken to describe facilities for supplying electric power, and such inquiries should be addressed to Secretary E. F. Riley, Madison, Wis.

We are indebted to Professor Jackson and the officials of the University for the information given.

A PROCESS OF FIREPROOFING WOOD FOR THE WOODWORK OF WAR SHIPS.*

By C. J. Hexamer.

A process for fireproofing the wood of war vessels must possess the following qualifications: (1) The material deposited in the fiber of the wood must render it thoroughly incombustible; (2) moisture or water, whether fresh or salt, must not affect the materials in the wood, in other words, they must be insoluble; (3) the impregnating matter must adhere permanently to the fiber so that it cannot be shaken out by any amount of wear or jarring; (4) glycerin or like hygroscopic substances, used in conjunction with other chemicals to render theatre scenery incombustible, must not be used, as they would tend to rot the wood; (5) the entire mass, not the surface only, must be equally well protected by the fire-resisting substance, because in battle the woodwork is broken and shattered, and external applications permeating the wood but a short distance, though valuable in ordinary buildings, would be useless for the former purpose.

Water is not only our cheapest solvent, but also the one universally obtainable, and therefore best suited to be used on a large scale. For this reason I concluded to employ a substance soluble in water in the primary saturating liquid, which, in turn, was to be rendered insoluble by precipitation in the fibers by an aqueous solution of another substance, forming with it an insoluble compound. Such a process, with ideal substances, would possess the additional advantage that the insoluble compound would be precipitated, as infinitesimal particles, into the very fibers of the wood, causing it to remain there permanently. No amount of jarring or vibration could shake it out, for, like a soluble dye-stuff made fast or insoluble by a mordant in textile fabrics, it would last as long as the fibers in which it is imbedded.

Injection into the fibers of the entire mass, and the precipitation there of an insoluble fire-resisting compound is, therefore, the desideratum. The question naturally arises, how can a solution be forced into the innermost recesses of the fibers of thick masses of wood? I knew that the most reliable experimental work regarding the saturation of wood with solutions had been done in connection with various attempts to preserve it against rotting and the teredo or ship worm. Before, therefore, beginning to experiment blindly, I carefully studied what had been done in this direction; examining technical books and journals, Wagner's "Jahrbuecher," the reports of committees, boards of inquiry, state commissions, patent reports and processes in actual use.

As a result of my studies and experiments, I came to the conclusion that the best method for impregnating the entire mass of the wood was to subject it to the following process: In the first place, use only well-seasoned timber, thoroughly air and kiln-dried, and worked approximately into the dimensions needed, or, better still, impregnate, whenever possible, the finished articles. Then place the wood in a stong metal chamber, specially made for the purpose, capable of withstanding strong pressures, and supplied with a lid that closes it hermetically. The receptacle is surrounded by a steam jacket, so that the temperature in it can be regulated at will. The interior of the chamber must be thoroughly dry before the wood is placed there. Let me caution you against steaming lumber before saturating it, a custom still prevalent in many creosoting works. The laborious tests of Drude have conclusively proved that steaming wood before impregnating it with solutions tends to lessen its absorptive powers, and that, therefore, it should be as dry as possible. The temperature in the receptacle is slowly increased above the boiling point of water, which is maintained until all the moisture in the wood has been expelled and the mass is equally heated throughout. The chamber is then hermetically sealed and the temperature in it is reduced to 60° C., and held there. The air in the receptacle is now extracted as quickly as possible by means of an air pump. The more complete the vacuum the better will be the ultimate results. Few persons have any idea of the amount of air contained in porous substances like wood. After the air in the wood has been removed a solution of water glass in about three times its volume of water, previously heated to 60° C., is sprayed into the vacuum. This method of injection is used to remove the air in the solution. The solution must not be too dilute, but at the same time not so thick as to refuse to enter the finest tissues of the wood; in other words, it must be of such a consistency that after impregnation it is completely retained in the pores. It is almost needless to add that the final results depend on the completeness with which the moisture, sap and air have been removed from the wood before impregnation.

I will not weary you by recounting the lengthy list of materials employed as a primary impregnating fluid, only to return at last to the one with which I had started —soluble glass, one of the best known of fireproofing materials, which possesses the additional advantage that it is cheap.

I might state here that for ordinary purposes a block of wood can be made fire-resisting by repeatedly soaking it in a water-glass solution, and, when dry, coating it with a mixture of the liquid and cement.

To return to the process, when the wood has become saturated with the solution at normal conditions, hydrostatic pressure of about ten atmospheres is applied, which is kept up for three hours; this drives the liquid through the mass. Numerous experiments made in Germany for the conservation of wood (see Mitthellungen des technologischen Gewerbemuseums, Abtheilung, Holz) have conclusively demonstrated that the "hydrostatic-pressure method" is the only one to be relied upon for forcing solutions to the innermost parts of a log.

The question now becomes what to use to precipitate insoluble silica from the solution of soluble glass, thereby forming an insoluble compound in the fibers? A dilute solution of hydrochloric acid was tried at first, but this affected the wood, and would in practice attack metal receptacles. Gaseous and liquefied carbonic acid were experimented with, also calcium chloride, until finally a solution of ammonium chloride, a very cheap substance, was used with excellent results. This produces in the very fibers of the wood a gelatinous precipitate of silica, most suitable for our purpose; salt, which is readily removed from parts near the surface by soaking in water, tending to preserve the wood in the interior; and ammonia gas, which goes off per se.

To apply this secondary liquid the water-glass solution is drawn from the receptacle, and the before-described process is repeated with the ammonium chloride solution. In practice it may be found advantageous to use a second receptacle, removing the wood from one to the other. The pressure should be applied gradually in the second treatment, so as not to force out the first solution. After the precipitation has been completed the wood is thrown into a stream of running water to dissolve and wash out the salt near the surface, and is then slowly dried.

It may be of interest to add that, as a secondary result of my experiments—by using stronger solutions than are necessary for fireproofing purposes—I had some beautiful specimens of petrifaction, and Dr. Keller so completely turned a piece of filter paper into stone, that it seemed to be a delicate film of some pure white silicious mineral, and no one could possibly have surmised what the substance originally was. It is, therefore, possible that this process can be utilized in the arts in the future to petrify organic substances.

It will probably be urged that my process is expensive; but in a case like this expense is not a factor. We cannot afford to take the risk of not having everything possible about a man-of-war—or for that matter of any ship—fireproof, when upon that fact may depend a victory or a defeat of our navy. Nor is the expense as great as it at first appears; for the government should attend to this work itself, and not leave it to contractors. In point of fact, I believe it will be found that the only considerable outlay necessary would be the first cost of the large air-tight receptacles. There are, no doubt, plenty of pumps on hand that could be utilized, the amount of labor required is trifling, the chemicals used are of the cheapest, and the plant can be located in a place where running water costs nothing. I therefore fail to see any

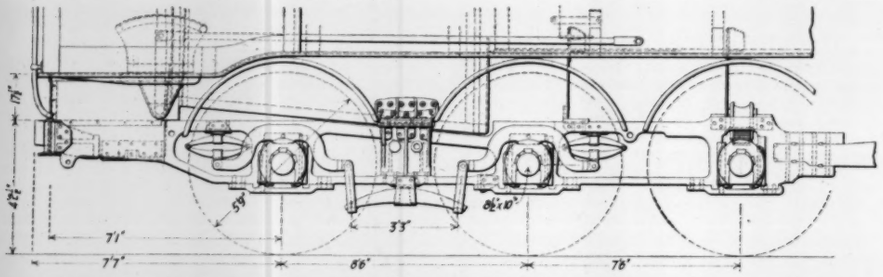
*Abstracted from a paper read before the Franklin Institute, Nov. 16, 1898.

possible reason why lives on ship should be endangered by fire in the future.

I beg leave to state, in conclusion, as my humble opinion, that everything on board of a ship can be made fireproof. Some things, of course, must be excluded by necessity, such as food, fuel and ammunition.

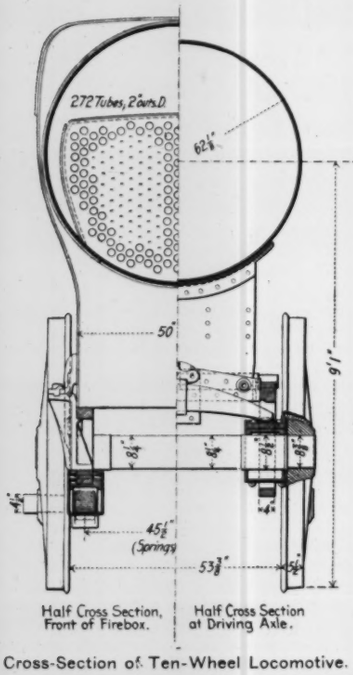
TEN-WHEEL PASSENGER LOCOMOTIVE; BUFFALO, ROCHESTER & PITTSBURG RY.

Within the past few years the Buffalo, Rochester & Pittsburg Ry. has materially increased the capacity of its locomotive equipment by the introduction of new and powerful engines, and we illustrate herewith one of five large ten-wheel passenger engines which have recently been built for this road by the Brooks Locomotive Works, of Dunkirk, N. Y. We are indebted to the builders for photographs and particulars of the engines.



PART OF FRAME, EQUALIZING LEVERS AND SPRINGS FOR TEN-WHEEL LOCOMOTIVE.

All the wheels have flanged tires, and the spring rigging of the two rear driving axles is somewhat peculiar. Over each axle box is a yoke like an inverted U with long horizontal arms. From the inner arms of the two yokes are suspended hangers for the equalizer, which is a large inverted semi-elliptic leaf spring. The outer arm of each yoke is attached to the bottom strap of an elliptic plate spring, the top strap being seated under the frame. The journals of the driving axles are 8½ × 10 ins., and those of the truck wheels are 5½ × 10 ins., while the main crank pin (which is hollow) is 6 × 5½ ins.



Cross-Section of Ten-Wheel Locomotive.

The cylinders are fitted with the Brooks type of piston valves, and have 3½-in. piston rods, with the United States metallic packing. Deep "alligator" crossheads, with two-bar guides, are used; and the connecting rods are of I-section. The coupling rods are flat, fish-bellied in shape, with solid ends.

The boiler is of the Player improved Belpaire type, having a throat sheet connection between the flat-top firebox and the boiler barrel. The bell and sandbox (with air-jet device) are on the barrel, the dome is on the throat sheet, and the whistle and safety valves are mounted on a special fitting on top of the firebox. The firebox, which is intended to burn bituminous coal, is above the frames, and is fitted with a fire-brick arch supported on studs. The mud ring is 4 ins. wide in front, and 3½ ins. at the sides and back. The smokebox is 5 ft. 1 in. in length, and has Bell's spark arrester and a large cinder discharge chute. The safety valves are of the Kunkle pattern, and the fittings include the Michigan sight-feed lubricators, and the Hancock composite injectors. The cab is large, built of sheet steel, and has the builders' special form of window.

The tender is of the usual eight-wheel type, with a framing of steel channels. The trucks have diamond frames and double elliptic springs. Spoke wheels are used, 33½ ins. diameter, and the axles are 4¼ ins. diameter at the middle, and 5⅝ ins. at the wheel fit, with journals 4¼ × 8 ins., 6 ft. 3 ins. c. to c. The tank is of U or horseshoe shape, built up of steel plates 3-16 in. and ¼-in. thick. It is 19 ft. 6 ins. long, 9 ft. 10 ins. wide and 3 ft. 10 ins. high, exclusive of the collar. The length of the tender over bumper beams is 22 ft. 1½ ins., and at the rear is a Trojan (M. C. B.) automatic coupler. Every wheel of the engine and tender is fitted with brakes. The Brooks outside equalized brake is used for the driving wheels and engine truck wheels, with the Westinghouse automatic brake for the tender and train. A 9½-in. brake pump is used.

The general dimensions of the engine are given below in our standard form:

Ten-Wheel Passenger Locomotive; Buffalo, Rochester & Pittsburg Ry.

Running Gear:	
Driving wheels (6), diameter	5 ft. 9 ins.
Truck wheels (4), diameter	2 " 6½ "
Tender wheels, diameter	2 " 9½ "
Driving-wheel centers	Cast steel.
Journals, driving axles	8½ × 10 ins.
Wheelbase: Driving	14 ft. 0 "
Total engine	24 " 3 "
Engine and tender	51 " 10¾"
Length over engine and tender	61 " 5⅝"
Weight in Working Order:	
On driving wh'ls, 108,000 lbs.; on truck wh'ls.	34,000 lbs.
Engine, total	142,000 "
Tender loaded	98,000 "
Cylinders: Number	Two.
Diameter and stroke	18 × 26 ins.
Cross head and guides	Alligator.
Connecting rod, length between centers	9 ft. 8 ins.
Valve Gear: Type	Link.
Ports, steam	2 × 21 ins.
Ports, exhaust (least area)	50 sq. ins.
Bridges, width	3¼ ins.
Slide valves ... Piston; maximum travel	7 "
" inside lap (steam)	1⅛ "
" outside lap (exhaust)	⅛-in.
" lead (full gear) variable;	1-16-in. negative.
Boiler: Type	Player-Belpaire.
Barrel diameter inside smallest ring	5 ft. 2 ins.
Dome, diameter	2 " 6 "
Thickness, barrel plates	⅝-in.
Thickness, smokebox tube-plates	⅝-in.
Horizontal seams	Quintuple-riveted.
Circumferential seams	Double-riveted.
Height, rail to center line	9 ft. 1 in.
Length of smokebox	5 " 1 "
Spark arresting device	S. Bell's, with wire-netting.
Working steam pressure	200 lbs.
Firebox: Type	Long; above frames.
Length, inside....9 ft. 0 ins.; width, inside	....3 ft. 6 ins.
Depth at front ....6 " 3 " ; depth at back	....5 " 0 "
Thickness, side plates, ⅜-in.; back plate	⅜-in.
" crown plate, ⅜-in.; tube plate	⅝-in.
Crown stays	Direct.
Grate bars	Cast iron; rocking.
Fire-brick arch	On studs.
Water spaces, width, front, 4 ins; back, 4½ ins.; sides, 6 ins.	
Tubes—Charcoal iron; No.	272
Thickness	No. 12 B. W. G.
Diameter, outside	2 ins.
Length over tube-plates	13 ft. 2¼ ins.
Heating Surface and Grate Area:	
Heating surface, tubes (interior area)	1,802 sq. ft.
" " firebox	195 "
" " total	2,028 "
Grate area	30.6 "
Miscellaneous:	
Exhaust nozzle (single), diameter	4¼, 4⅝, 5 ins.
Exhaust nozzle, distance above center line of boiler	3 "
Smokestack (steel), diameter	14¼ to 15⅝ "
" height of top above rail	14 ft. 11½"
" height above smokebox	3 " 2 "
Capacity of tender tank	4,500 galls.
Capacity of coal space	10 tons.

TELEPHONE STATISTICS FOR THE WORLD have been published by the State Department. The number of instruments in use in leading countries is put down at 1,288,163, and the distance covered by the lines is 1,509,499 miles. Of these the United States has 772,627 instruments, and 805,723 miles of lines. Germany comes next with 151,201 telephones and 147,092 miles of lines; Great Britain has 69,645 instruments covering 83,401 miles; and Sweden has nearly as many, the figures being 56,560 and 74,568, respectively. After these countries, and at some distance after, come Canada, Switzerland, France, Austria, Norway and Russia, in the order named. France had only 27,736 telephones in 1894, and Russia 18,495 in 1896.

THE NEW BUSINESS POSTAL-CARD, authorized by Congress May 19, 1898, must be 3¼ × 5½ ins., weight 6 lbs. 3 oz. to the 1,000, and be white, cream, light gray or light buff in color. The business of the issuer may be printed on the address side, in brief form, and this side must also contain the words: "Private mailing card, authorized by Act of Congress, May 19, 1898," and in the upper right-hand corner must be a space marked: "Place a stamp here." Any one conforming to these regulations may print and issue these cards. The present contract for the printing of postal-cards, for four years, was made on Dec. 1, 1897; they are made at Piedmont, W. Va., and cost the government a little less than 24 cts. per 1,000. They include the common postal-card, 3¼ × 5½ ins.; the double or answer card and the small, single postal-card, 3 × 5 ins. The estimated number of postal-cards required by the government during the four years is 2,075,000,000, of which 20,000,000 are of the double type. As the user of the private mailing card prints his own card and pays as much for the government postage stamp as he would for the government stamped postal-card, the government is the gainer by the cost of the card.

THE PHILADELPHIA EXPOSITION OF 1899, for the development of American manufactures and expansion of the export trade of the United States, now has $850,000 available, through congressional, state and city aid. It is conducted under the joint auspices of the Philadelphia Museum and the Franklin Institute, and will open on Sept. 14 and close on Nov. 30. The main buildings, now being erected, will cover over eight acres on the west side of the Schuylkill, on 56 acres of land donated by the city, between the Blockley Almshouse and the Philadelphia, Wilmington & Baltimore Railway. The main group of buildings will form one connected structure, 400 × 900 ft., and contain 200,000 sq. ft. for exhibition purposes.

PENNSYLVANIA ANTHRACITE PRODUCTION in 1898, according to the March bulletin of the Anthracite Coal Operators' Association, amounted to 47,138,047 tons, of which 42,059,085 tons were shipped. Of the total shipments, 26,337,614 tons were from collieries owned by railway companies, and 15,721,421 tons were from the collieries of private operators.

A MAP OF WEST VIRGINIA has been compiled and published by Mr. Russell L. Morris, C. E., for the West Virginia Geological and Economic Survey, Mr. I. C. White, State Geologist. This is said to be the only map of the state that approaches accuracy. It contains most of the post offices, and indicates, in color, the oil pools, natural gas wells and the New River, Allegheny and Pittsburg coal areas. It is made on a scale of 10 miles to the inch. The address of Mr. Morris is Department of Engineering, West Virginia University, Morgantown, W. Va.

THE NEW STATION OF THE LYONS RAILWAY in Paris, is being built under a temporary wooden structure completely covering the proposed station, and protecting the workmen from snow, rain and cold. Glass admits light in the daytime and at night electric light is used; the building is also heated. Continuous work is thus made possible. This is not an unusual practice in Paris, as a similar protective was used in constructing the New York Insurance and other large buildings in that city. The desire to complete this important station in time for the Exposition of 1900 is the especial incentive in this case. The new work is to cost about $5,000,000, and includes the enlargement of the trainshed so as to hold 13 tracks and the building of a main façade on the Boulevard Diderot. The width of the new station will be 515 ft., or about double that of the old one, including all structures, and the trainshed is 288 ft. wide, with a line of posts down the center. This station is fully illustrated and described in "Le Genie Civil" of March 4, 1899.